Evidence of selection in a mandatory health insurance market with risk adjustment

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ABSTRACT

This paper aims to identify selection separately from moral hazard in a mandatory health insurance market where enrollees can freely choose their deductible scheme. The empirical analysis uses a unique dataset for the period 2010-2013 covering the whole population of the Netherlands at enrollee level, allowing us to use prior health expenses of the enrollees to demonstrate the selection effect separately from the potential moral hazard effect. Our estimates show that the enrollees who opt for deductibles are both healthier and have a higher risk-adjusted result (i.e. the difference between the compensation from the risk-adjustment fund and the actual health care cost) under the prevailing risk-adjustment system. Compared to enrollees who have chosen the lowest available deductible level, enrollees who have chosen the highest deductible level have an average risk-adjusted result that is approximately €450 higher per enrollee. An option that the Dutch government could consider to fully eliminate the risk-adjustment gain of the deductibles is to include the choice of a voluntary deductible in the risk-adjustment system as one of the characteristics of the consumer. Our detection of substantial selection effect of deductibles suggests the need of further research to understand in greater detail the relationship between premium discounts and the expected gains on the risk-adjustment for enrollees with a voluntary deductible.

1. INTRODUCTION

In order to mitigate market failures and increase affordability in health insurance markets, regulators in several countries, including the Netherlands, set rules for consumers and insurers. Most importantly, these rules oblige insurance companies to accept all applicants (open enrollment) and to offer health insurance policies at the same price to all persons (community rating). An other important rule is to oblige all citizens to enroll in health insurance[67].

Generally, a risk-adjustment system is in place to provide a level playing field for the insurers. A perfect risk-adjustment system eliminates the predictable profits (losses) on low-risk profile (high-risk profile) enrollees emanating from community rating. In that case, insurers have no incentives to select low-risk enrollees or to offer products that are attractive to low-risk enrollees[68].

The Dutch risk-adjustment system began simply and has gradually been improved. However, even a state-of-the-art system cannot remove incentives for exploiting the mechanism of selection fully (van Kleef, McGuire, van Vliet, & van de Ven, 2017). There are still incentives for the insurers to sort low-risk and high-risk enrollees into different health plans by designing different health plans for different risk profiles. Because health plans may be priced independently, this would result in premium differentiation according to risk profiles and risk-based sorting across plans. Such selection decreases solidarity and induces social welfare losses (Cutler, Zeckhauser, et al., 1997). In the literature on selection, there is a focus on (*i*) the relationship between risk-type and the demand for contracts with generous reimbursement (i.e. adverse selection) and (*ii*) the incentives for health insurers to select low-risk individuals by tailoring insurance options to attract them (Newhouse, Price, Hsu, McWilliams, & McGuire, 2015; Newhouse, Price, Huang, McWilliams, & Hsu, 2012; Einav & Finkelstein, 2011; Rothschild & Stiglitz, 1976).

Empirical identification of selection is challenging because of the interaction of selection with moral hazard (Cohen & Siegelman, 2010). Using a unique dataset on the Dutch health insurance market, this paper contributes to the existing literature by showing empirically that the possibility for consumers to opt for voluntary deductible can results in selection, even in a health insurance market with a risk-adjustment system in place. By taking account of the past health costs and focusing on whether consumers opt for deductibles, we are able to identify the selection effect separately from moral hazard

67 For a description of this general idea see e.g. van de Ven and Ellis (2000).

68 However, a recent theoretical insight from Bijlsma, Boone, and Zwart (2014) suggests that selection could exists even in a market with optimal risk-adjustment. When the health insurance market is imperfectly competitive and healthy consumers have a higher price elasticity than the high-risk consumers, enrollees can still be 'sorted' into health plans with different prices and coverage .

effect. Further, we examine the selection effect separately in terms of adverse selection and in terms of the incentives for health insurance to select low-risk enrollees.

With our study, we improve the understanding of selection in managed competition settings. Our result is therefore also relevant for other health care systems with managed competition, such as Medicare Advantage and Part D in the United States.

In the remainder of this paper we will discuss the previous literature in section 2 explain the organization of the Dutch health insurance sector in section 3. This is followed by the exposition of our empirical approach in section 4, after which we describe the data and our empirical findings in sections 5 and 6. Section 7 ends with concluding remarks.

2. LITERATURE

In this section we focus on the previous literature on voluntary deductible and the empirical identification of selection in health insurance markets.

Voluntary deductibles

In the Netherlands there is the possibility to choose from five different levels of voluntary deductible in exchange for a premium discount on the basic benefit package. Although less than 11% of the Dutch insured chose voluntary deductibles in 2014, the group of enrollees with voluntary deductibles is growing every year (NZa, 2014; Vektis, 2017).

Looking at the potential effects of voluntary deductibles from the perspective of the economic literature, the following opposite effects can be highlighted. On the one hand, deductibles reduce the effect of moral hazard. Individuals incur lower health care cost if they are enrolled in a health plan with a higher deductible (Newhouse, 2004; Aron-Dine, Einav, & Finkelstein, 2013). Most studies attribute this cost reduction to lower health care utilization (Keeler, 1992; Gern & Schellhorn, 2006; Wharam et al., 2007), rather than to choosing cheaper hospitals. Lower health care utilization is desirable when it applies to care valued below its cost[69].

On the other hand, deductibles are an instrument of selection. Rothschild and Stiglitz (1976) shows that due to the private information available to consumers, selection results in the underinsurance of low-risk enrollees. Moreover, since deductibles are only attractive for enrollees with lower expected costs, they allow for selection by insurers (van Kleef, Beck, van de Ven, & van Vliet, 2008; Tollen, Ross, & Poor, 2004).

69 Note that enrollees who have to pay deductibles (or a co-insurance rate) may reduce or postpone necessary health care treatment (Brot-Goldberg, Chandra, Handel, & Kolstad, 2015; Fronstin & Collins, 2008; Lohr et al., 1986; Davis, Doty, & Ho, 2005; Galbraith et al., 2011).

More specific to our context, van Winssen, van Kleef, and van de Ven (2016) argue that in the Netherlands voluntary deductibles mitigate moral hazard, but it also involves an (adverse) selection component. The Dutch Healthcare Authority has found that enrollees who choose a voluntary deductible have a higher risk-adjusted result than enrollees who choose no voluntary deductible (NZa, 2016). However, the mere fact that enrollees who choose a voluntary deductible have a higher risk-adjusted result does not, in itself, prove selection. It also may be due to the fact that these enrollees consume less health care because they wish to avoid paying the higher deductible (moral hazard). Therefore, the finding suggests that a more elaborated analysis is still needed in order to disentangle the two effects.

Identification of selection

There is a growing body of empirical literature on identifying selection in health insurance markets. For example, Panthöfer (2016) finds adverse selection in the German public health insurance market. Olivella and Vera-Hernández (2013) test for asymmetric information in the UK private health insurance market and find evidence for adverse selection. Dardanoni and Donni (2012) find significant adverse and advantageous selection in the US Medigap insurance market. Bolhaar, Lindeboom, and van der Klaauw (2012) find that information asymmetry is present in the supplementary health insurance in the Netherlands. For an extensive review of the empirical literature on the relationship between coverage and risk see Cohen and Siegelman (2010) and Aarbu (2017).

We conduct a version of the positive correlation test, which is described in Chiappori and Salanie (2000), to determine the extent of selection on the market. A positive correlation test assesses, conditional on observables, if there is a correlation between the choice for a contract and the occurrence or severity of an accident, which is in our case health care expenditure.

We take broadly a similar approach to Abbring, Heckman, Chiappori, and Pinquet (2003), who suggest testing for selection by studying the relationship between behavior under a contract and subsequent amendments to that contract. In this paper, we focus on an amendment to a contract in the light of past behavior. To disentangle moral hazard and selection in our paper, we will look at the history of health care consumption by enrollees *prior* to their decision to choose a voluntary deductible. At that point, enrollees' behavior with respect to health care expenditure is not influenced by the subsequent uptake of deductible, which can be seen as a contract amendment in the context of Abbring et al. (2003).

3. INSTITUTIONAL CONTEXT AND RISK-ADJUSTMENT MODEL IN THE NETHERLANDS

In the Netherlands, health insurance is provided by private insurers that compete mainly on premiums. Since 2006, all citizens have been legally required to take out insurance in the form of a standardized basic benefits package, which is defined by the government. Insurers are obliged to offer this basic package in any health plan they offer. Community ratings are applied, meaning that insurers may not differentiate premiums among enrollees of the same health plan[70]. Insurers can offer a voluntary deductible to its enrollees. Deductible options of €100, €200, €300, €400 and €500 are permitted. Here, too, insurers are not allowed to differentiate the price discounts associated with voluntary deductible options between enrollees of the same health plans. Note also, that the deductible option is added on top of the mandatory deductible (€350 in 2013), which was introduced to cope with moral hazard in health care consumption and to reduce public expenditure on health care. We analyze only the effect of optional voluntary deductible taking the mandatory deductible as given.

The insurance system is funded as follows. Approximately 50% of the total insurance revenue is raised from the premiums paid directly to the insurers and the out-of-pocket expenses falling under the deductibles. The other 50% is raised through an income-dependent premium determined by the government and collected by the tax office. The system of income-dependent premiums is meant to guarantee income solidarity and to keep insurance affordable. The core of this system is the risk-adjustment model: the tax office transfers the income-dependent premiums into the risk-adjustment fund, which in turn distributes these in the form of risk-adjusted capitation payments to the insurers.

Risk adjustment

The risk-adjustment model works at the level of individuals. The payments from the risk-adjustment fund to an insurer are based on a number of characteristics of the insurer's enrollees in order to compensate for differences in expected health costs of the enrollees. The used characteristics define risk classes related to the health status and other characteristics of an enrollee. These risk classes group individuals into health cost categories that are deemed predictive of their health care costs in the subsequent year.

The past health status of individuals is captured by diagnosis-cost classes for both physical and mental care, pharmacy-cost classes, and multi-year high-cost classes,

70 Insurers may offer a discount on group contracts up to a maximum of 10%. In 2015, these discounts were on average 4.4%. Insurers with less than 850000 enrollees may also offer regional policies accessible only to inhabitants of a particular region.

based on the past health care consumption of the individual.[71].The additional individual characteristics are captured by age-gender classes, income-source risk classes (benefit-receivers, self-employed and a rest category), socio-economic status risk classes (grouping individuals into three income levels and a separate category for enrollees who reside at an address with more than 15 others, for example a nursing home), region risk classes (grouping individuals into geographic clusters), and a risk class for one-person households.

The risk-adjustment model works as follows. Each year, the normative marginal cost values for each risk-adjustment class are determined by means of a regression of health care costs on the individual characteristics listed above. This estimation is done at the individual level. As a result, the expected health care cost of each enrollee can be estimated. The risk-adjustment fund is distributed among the insurers based on the predicted cost of their population minus an administrative premium that is set by the government.

The difference between the estimated costs as determined by the risk-adjustment fund and the actual health care cost of each individual equates to 'the risk-adjusted result' of the enrollee. The risk-adjusted result in the whole population is normalized to zero. Since the risk-adjustment model includes adjustment for mandatory deductible payments which the insurer receives directly from the enrollees, the variable 'risk-adjusted result' is adjusted for the profits and losses due to the mandatory deductible[72].

Ideally, predictable health-related cost differences between enrollees should be fully eliminated by this system, leaving the insurers no incentive for selection. Significant effort is therefore devoted to improving the risk-adjustment model. Yet, not all predictable cost differences can be eliminated due to some private information, which leaves scope for selection.

Until 2012, the system also included significant ex-post additional compensations that applied when the predicted and realized health care costs diverged substantially. However, these ex-post adjustments have been phased out in recent years. Due to this decrease in risk-sharing, the incentive for selection has increased if the improvements in the risk-adjustment system are not sufficient to counteract it.

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71 Consumption in the previous year except the multi-year high-cost classes where the consumption of the previous three years is considered.

72 In particular, a separate model within the risk-adjustment system predicts the amount of out-of-pocket payment related to the mandatory deductible that each enrollee would pay in the current year. This amount is subtracted from the predicted health care cost of the enrollee. However, the predicted out-of-pocket payment may diverge from the realized payment (just like there may be a difference between the predicted and realized health care costs) which means that the insurer may have a profit or a loss in this part of the system as well.

Health plans

In 2013, 10 insurers offered 67 different health plans. These health plans cover the same basic insurance package, but differ in some details with respect to both their coverage and pricing. While traditional health plans have only minor differences with respect to the choice of health care providers for enrollees, since 2008 there have also been health plans with a restricted network of health care providers (these plans require out-of-pocket payment for visiting non-contracted providers). The market share of these health plans was about 8% in 2015 (NZa, 2015).

Each health plan offers discounts for voluntary deductibles. Enrollees who opt for a contract with a voluntary deductible benefit from premium discounts, depending on the size of the deductible chosen. A higher deductible is associated with a greater discount. In 2013, the average annual premium was €1269. The maximum voluntary deductible of €500 corresponded to an average discount of €230, which is 18% of the average premium. The situation was similar in the preceding years[73]. Figure 1 illustrates the discrepancies in the deductible discount schedules over the different health plans, showing that there are quite large differences between health plans in terms of the premium discounts available for each deductible level.

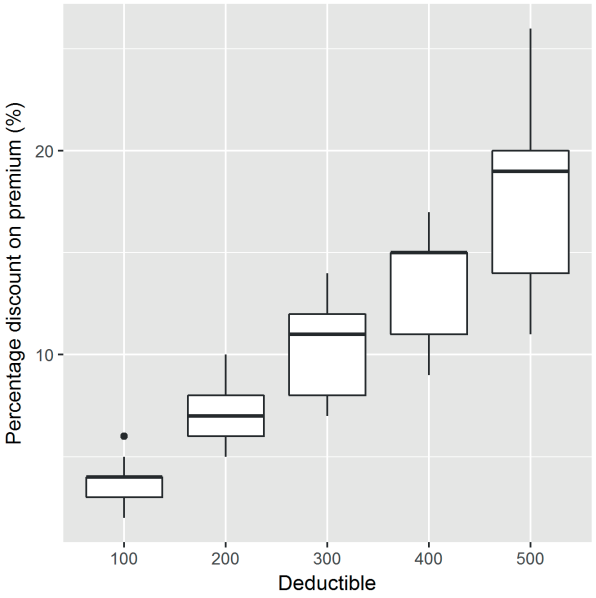
Insurers can offer for each deductible level a discount on the health plan's premium. Insurers may not differentiate the discount among enrollees of the same health plan. In this graph, for each deductible level the average discount is calculated by taking the average of the health plans' discounts.

About 9% of enrollees over the age of 18 (the age at which the deductibles may be applied) chose a contract with a voluntary deductible in 2013, and the majority of them chose the maximum level of €500. The distribution of the share of enrollees who chose the maximum level of €500 in their health plans in 2013 is shown in Figure 2. We can observe large variation in the share of enrollees who chose the maximum deductible level of €500. Some health plans have a share that is lower than 5%, while one health plan has a share that is around 60%.

For each health plan, we calculated the share of enrollees that have chosen the maximum deductible level in 2013. We excluded health plans that have less than 1000 enrollees.

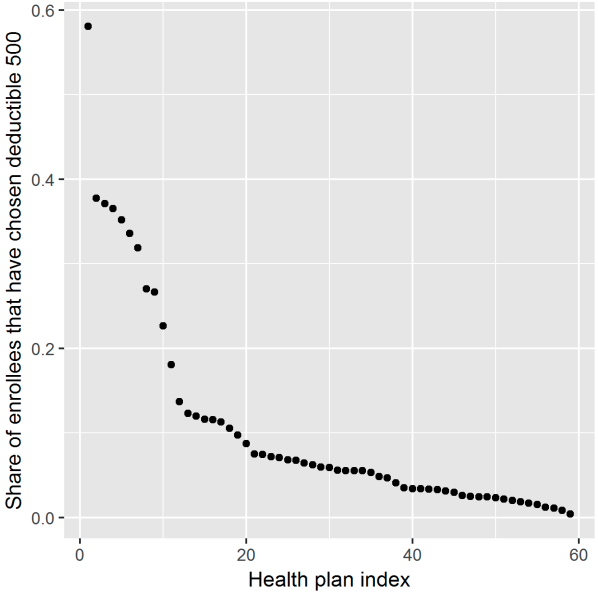
73 For the other voluntary deductible levels, the average discounts were €45 (€100 deductible), €88 (€200 deductible), €131 (€300 deductible) and €175 (€400 deductible).

Figure 1. Boxplot of discounts offered at different deductible levels in 2013



Insurers can offer for each deductible level a discount on the health plan's premium. Insurers may not differentiate the discount among enrollees of the same health plan. In this graph, for each deductible level the average discount is calculated by taking the average of the health plans' discounts.

Figure 2. Share of enrollees with deductible level €500 in 2013



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4. EMPIRICAL STRATEGY

In this paper, we are interested to determine (*i*) how strong the relationship is between risk-type and the choice for deductibles (i.e. the degree of adverse selection) and (*ii*) the incentives for insurers to attract enrollees into healthplans with a voluntary deductible in terms of the risk-adjusted result. Note that the most important channel for a health insurer to attract enrollees into healthplans with a voluntary deductible is by offering substantial (community-rated) premium discounts.

To determine both the degree of adverse selection and the incentives for insurers, we perform the conditional correlation test that was proposed by Chiappori and Salanie (2000) and further developed by Chiappori, Jullien, Salanié, and Salanie (2006) and Finkelstein and McGarry (2006). Our analysis follows the application of this test by Aarbu (2017), who examined the presence of asymmetric information in the home insurance market.

In short, to determine the degree of adverse selection we estimate an OLS model on the individual enrollee level to determine if enrollees with a high deductible level have low health care costs. To determine the incentives for insurers to offer deductibles to enrollees, we also estimate an OLS model on enrollee level. However, in this model we determine if enrollees with a voluntary deductible have high risk-adjusted results compared to enrollees with no voluntary deductible.

A challenge with the conditional correlation test is to disentangle the moral hazard effect from the adverse selection effect. Finding that there is a relation between deductible level and health care costs can be explained by both adverse selection (the relationship between risk-type and the demand for deductible) and moral hazard (the hypothesis that enrollees who have chosen a deductible consume less health care because they face out-of-pocket payments). The same holds for the relation between deductible level and risk-adjusted results.

To disentangle moral hazard and adverse selection in our paper, we will look at the history of health care consumption by enrollees *prior* to their decision to choose a voluntary deductible. At that point, enrollees' behavior with respect to health care expenditure is not influenced by the subsequent uptake of deductible.

What follows is a more formal exposition of the conditional correlation test for the examination of adverse selection and the incentives for insurers.

The health care cost of enrollee i, $cost_i$ depends on the health status and other characteristics of the enrollee, X_i. The deductible chosen by enrollee i, $deductible_i$ is also a function of characteristics of the enrollee. Therefore, we obtain a system of equations of the form

$$cost_i = g(X_i, \mu_i) \tag{1}$$

$$deductible_i = h(X_i, v_i) \quad (2)$$

where μ_i and v_i are the error terms from the cost equation and the deductible choice equation.

If there is no asymmetric information, and vector X contains all the relevant characteristics used by the insurer, then the error terms μ and v will be uncorrelated. However, if there is a variable with a positive impact on health care costs that is not included in the list of characteristics X, then the error term μ will pick up the effect that this variable has on health care costs, *cost*. According to the literature, see section 2, high-risk enrollees will self-select in a contract with more generous coverage. Hence, a higher value of μ will be observed together with a lower value of the deductible, and thus, with a lower value of v. A significant negative correlation between the error terms μ and v will, therefore, demonstrate the presence of asymmetric information.

Under a conditional independence assumption, this test can be conducted by using reduced-form OLS equation in which *cost* is the dependent variable and *deductible* is the independent variable:

$$cost_i = \alpha\, deductible_i + \beta X_i' + \gamma Z_i' + \in_i \quad (3)$$

where *cost* denotes the health care costs, *deductible* is the choice of deductible, X is a vector of consumer characteristics, Z contains all other health plan related relevant variables, and $\in$ is the error term. The letters α, β and γ are parameter vectors. We expect a negative relationship between the cost and the deductible. However, it is important to control for enrollees' risk aversion, since there may be a bias in the single-equation OLS model if (*i*) the choice of deductible is related to risk aversion and (*ii*) risk aversion is related to enrollee cost type (Finkelstein & McGarry, 2006; Aarbu, 2017). In our application we will include proxies for risk aversion based on several characteristics of the enrollees.

Since the current costs in each year contains both selection and moral hazard effects, one more step needs to be done in order to separate the selection effect from the moral hazard effect. To remove the moral hazard effect from the equation, we focus on the enrollees who had contracts without voluntary deductibles during three years before the year for which we conducted the estimation, year t. Additionally we replaced the health care costs incurred in that year with the health care costs of the previous year. This replacement results in the following specification for the reduced model, in which the dependent variable does not depend on the choice of a contract in year t:

$$cost_{i,t-1} = \alpha\, deductible_{it} + \beta X_{it}' + \gamma Z_{it}' + \in_{it} \quad (4)$$

In the presence of risk-adjustment, the same reasoning also holds for the risk-adjusted result variable, *result*. Therefore, this selection effect could also be demonstrated by using an alternative model specification with the past *result* as the dependent variable and *deductible* as the independent variable, in which a higher risk-adjusted result would be associated with a higher deductible level chosen.

However, this approach could introduce selection bias in our estimate of selection. By focusing on enrollees who had contracts without deductibles in t - 1, t - 2 and t - 3, we have a subsample of the population with different characteristics compared to the whole population. If these characteristics affect costs or risk-adjusted results, then we have potential bias in our estimation. We are not able to quantify this bias, however, we can try to give a direction of the bias. van Winssen, van Kleef, and van de Ven (2015) showed that in the Netherlands for a large share of enrollees who has not chosen any voluntary deductible would have been better of if they would have chosen a voluntary deductible. This means that our subsample may include an over-representation of enrollees that are less interested and/or less shrewd when choosing their deductible. If this is the case, then we may underestimate the adverse selection effect.

5. DATA DESCRIPTION

Data and defining the relevant subset for the empirical analysis

The data came from two sources: risk-adjustment data and health plan choice data. Both datasets are panel datasets, covering the entire population of the Netherlands, which exceeds 16 million enrollees per year, over the period 2010-2013.

Both datasets were provided by the Dutch Healthcare Authority. The risk-adjustment dataset comprises the characteristics of the enrollees included in the risk-adjustment system and the actual costs incurred by the enrollees. The individual characteristics and the cost types included were described in detail in section 2, where we also defined the concept of 'risk-adjusted result'. The health plan choice dataset is a complementary dataset that includes the insurance enrollment. These records provide the health plan details on each enrollee, including the deductible level chosen. As explained, enrollees can opt for or zero voluntary deductible or a voluntary deductibles of €100, €200, €300,€400 or €500. To conduct the analysis, both dataset were merged at the enrollee level.

Table 1 provides an overview of our dataset coverage (in insured years) and the amounts of costs included in the dataset in billions of euros. Since physical and mental

Table 1. Size of the dataset

year	Insured Years mln	total physical health care costs bln euro	total mental health care cost bln euro
2010	16.3	25.958	3.010
2011	16.4	26.508	3.299
2012	16.5	27.837	2.982
2013	16.5	29.736	3.071

health care costs are the major costs of health care[74], the cost variable that we use in our analysis are defined as the sum of these two cost components[75].

The table excludes observations with missing values and the observations relating to individuals who reside abroad (approximately 1% of all observations). In the analysis that follows, we also excluded enrollees younger than 18 years, since this group of enrollees does not have to pay any deductible (this implies excluding 20% of the population). Furthermore, we only selected enrollees that appeared in our dataset every year, so that we could follow each enrollee over the whole period (this implied excluding 11% of the population).

In order to conduct the test described in section 4 for the year 2013, we selected enrollees who did not choose a voluntary deductible in the previous years (2010 till 2012) in order to estimate the equations for the health care costs and risk-adjusted results for the year before the enrollees chose a voluntary deductible (i.e. 2012). By looking at the outcomes for health, costs and risk-adjusted results for 2012, before the enrollee chose a deductible, we were able to exclude the possibility that the voluntary deductible had affected the health, costs and risk adjusted results that we were examining. Next section provides some descriptive analysis of the selected subset of enrollees.

Descriptive analysis of the selected subset

For the selected subset of enrollees, we consider the relationship between their deductible choice in 2013 and some variables of interest, such as the health status, costs, risk-adjusted result, and expected out-of pocket expenses.

Table 2 shows the number of enrollees for each deductible choice in 2013, together with the share of healthy individuals in each subgroup. Here we classified an enrollee as 'healthy' if he or she was not included in any diagnosis-cost class, pharmacy-cost class or multi-year high cost class in 2012. These enrollees are considered as having no substantial health care costs in the period 2010-2012, which is deemed predictive of

74 Some fixed cost components are not included in risk-adjustment.

75 Note the difference between the risk-adjusted result and the cost variable: the cost variable that we use represents the incurred cost; this variable is neither adjusted nor normalized.

Table 2. For each deductible category the number of enrollees and the share of healthy in 2012. Only enrollees that have not chosen any voluntary deductible in the period 2010-2012 are taken into the calculation.

deductible 2013	enrollees	share enrollees classified as 'healthy'
000	10828669	0.57
100	25386	0.82
200	41442	0.83
300	23242	0.82
400	7925	0.82
500	265489	0.83

2013 health care costs according to the risk-adjustment model. The share of healthy enrollees among enrollees who did not choose any deductible in 2010-2012 and 2013 was 57%. The share of healthy enrollees was much higher among enrollees who did not choose a voluntary deductible in 2010- 2012 but who did choose a voluntary deductible of €500 in 2013: 83%. This descriptive analysis suggests that enrollees who choose a higher deductible level are more likely to be healthy.

Table 3 compares the mean values of health care costs, risk-adjusted results and counterfactual €500-deductible out-of-pocket expenses for 2012 (before choosing a deductible) and 2013 (after choosing a deductible) for each deductible category in 2013. We will explain below how we calculated the counterfactual deductible out-of-pocket expenses. The columns on costs provide insight in the health care use by the individuals; the columns on risk-adjusted results show profitability of each subgroup in risk-adjustment; and the counterfactual expenses characterize the attractiveness of a higher deductible option from the enrollees' perspective.

First, looking at the columns headed 'mean cost' and 'mean result' in this table, we observe that the mean 2012 health costs (mean 2012 result) for enrollees who did not choose a voluntary deductible in either 2010-2012 or 2013 are higher (lower) than the mean 2012 health costs (mean 2012 result) for the enrollees who did not choose a voluntary deductible in 2010-2012 but did choose a voluntary deductible of €500 in 2013: €2,261.68 vs. €600.29 (€-26.05 vs. €399.578)[76]. From this comparison, we can conclude that insurers have lower costs for enrollees who have chosen a voluntary deductible (higher risk-adjusted results). This applies to the year before they chose the voluntary deductible (2012) and it remains true for the year after they chose the voluntary deductible (2013). Although the costs in 2013 reflect not only the selection but also the moral

76 The risk-adjusted result was normalized such that its mean is equal to zero. However, the mean results presented in the table differs from zero because we use a subset of the population in our analysis.

Table 3. For each deductible category the mean costs, mean risk-adjusted results and mean counterfactual voluntary deductible 500 out-of-pocket expenses in 2012 and 2013. Only enrollees who have not chosen any voluntary deductible in the period 2010-2012 are taken into the calculation.

	mean cost		mean result		mean expenses	
deductible 2013	2012	2013	2012	2013	2012	2013
000	2262	2487	-26	-27	467	452
100	772	906	286	257	254	243
200	643	810	384	314	231	228
300	653	796	405	349	232	227
400	627	826	445	362	232	230
500	600	703	420	400	227	203

Combining the findings from Tables 2 and 3, we can therefore conclude that enrollees who chose a voluntary deductible in 2013 are: healthier and have lower counterfactual out-of-pocket expenses than enrollees who did not choose a voluntary deductible in 2013. At the same time, insurers incur lower costs and have higher risk-adjusted results for enrollees who chose a voluntary deductible in 2013.

hazard effect, the lower costs and positive risk-adjusted results in 2012 are a strong indication for the presence of selection and also indicates that the selection effect is much larger than the moral hazard effect.

The last two columns of Table 3 headed 'mean expenses' show the mean counterfactual values of out-of-pocket expenses that would have been paid by the enrollees under the €500 deductible option. Since there is also a mandatory deductible, which was €350 in 2013, we simulated the counter-factual situation in which each enrollee had chosen a voluntary deductible of €500 on top of the mandatory deductible of €350. In this case, each enrollee would have to pay any costs incurred up to €850. In the Netherlands, the deductible applies to almost all health care costs, but there are some exceptions; for example, payments for general practitioners (GP) are not included. In our dataset, for each enrollee we knew the exact costs that were taken into account for the deductible. Using these 'deductible costs' and limiting them to €850 euro, we were able to calculate the total counterfactual out-of-pocket expenses that each enrollee would have had to pay if he or she had chosen the maximum voluntary deductible of €500 euro in 2013. We calculated these out-of-pocket expenses based on the 2012 'deductible costs' (that is, before the choice of any voluntary deductible for 2013) and the 2013 'deductible costs' (after the choice of a voluntary deductible for 2013).

Focusing on the column headed 'mean expenses 2012' in Table 3, which shows these counterfactual values for the year 2012, we can see that the mean counterfactual out-of-pocket expenses in 2012 for enrollees who did not choose a voluntary deductible in either 2010-2012 or 2013 are higher than the same figure for those enrollees who opted for a voluntary deductible of €500 in 2013: €466.53 vs. €227.21. This holds for the year

before they chose the voluntary deductible (2012), and a similar result holds for the year after they chose the voluntary deductible (2013).

Table 4 shows the summary statistics of the variables discussed above in Table 3. In addition, Table 5 provides insight on how the risk-adjusted result varies in relation to the choice of a deductible in 2013 by the subset of enrollees who did not choose a voluntary deductible in 2010-2012, which we use in our empirical analysis. The table shows both the mean and the distribution of the risk-adjusted result over percentile groups for each deductible category. For example, we can see that 2.05% of the enrollees that did not choose a deductible in 2013 are in the [0*th*, 2*th*] percentile group, while only 0.46% of the enrollees who chose a deductible of €500 in 2013 are in the [0*th*, 2*th*] percentile group. Table 5 also includes the 2012 mean risk-adjusted result for each deductible category. The mean risk-adjusted result in the [0*th*, 2*th*] percentile group is €-27925.10, while the mean risk adjusted result in the (10*th*, 100*th*] percentile group is €1081.41. Thus, compared to the other deductible categories, a relatively large share of the enrollees who did not have any voluntary deductibles in 2013 fall into the lowest result percentile group [0*th*, 2*th*]. This last observation suggests that enrollees without a voluntary deductible are more likely to be loss-making in risk-adjustment.

Table 4. Summary statistics for cost, counterfactual (cf) out-of-pocket expenses and risk-adjusted result in 2012 and 2013. Only enrollees who have not chosen any voluntary deductible in the period 2010-2012 are taken into the calculation.

Statistic	N	Mean	St. Dev.	Min	Max
cost 2012	11192153	2208	5589	0	645275
cost 2013	11192153	2431	6664	0	806561
result 2012	11192153	-12	4761	-627524	81361
result 2013	11192153	-14	5769	-780855	88989
cf expenses 2012	11192153	459	367	0	850
cf expenses 2013	11192153	444	367	0	850

6. ESTIMATION

In this section we estimate the relationship between (*i*) costs in the previous year and the choice of a deductible for the subsequent year and (*ii*) between the risk-adjusted result in the previous year and choice of a deductible for the subsequent year. These are the test of our two hypotheses derived from section 4. We have tried to control as much as possible for enrollee heterogeneity and health plan heterogeneity. Enrollee heterogeneity entails differences in enrollee characteristics, in particular those that are relevant to risk-preferences. Health plan heterogeneity includes differences at the level of the insurer's health plan, for example the possibility that a particular health plan

Table 5. For each deductible category the distribution of population percentiles. Only enrollees that have not chosen any voluntary deductible in the period 2010-2012 are taken into the calculation.

percentile	result mean	result SD	share of deductible in 2013					
			000	100	200	300	400	500
[0th,2th]	-27925	23382	0.021	0.006	0.005	0.005	0.005	0.005
(2th,4th]	-9138	1486	0.021	0.007	0.007	0.007	0.006	0.005
(4th,6th]	-5722	665	0.020	0.011	0.010	0.008	0.009	0.007
(6th,8th]	-3878	423	0.020	0.012	0.010	0.011	0.013	0.009
(8th,10th]	-2685	283	0.020	0.013	0.011	0.011	0.010	0.010
(10th,100th]	1081	1787	0.898	0.950	0.957	0.958	0.958	0.965

may have a more cost-effective way of purchasing health care (lower costs) than the average health plan. We estimated the following equations separately for the costs and risk-adjusted result:

$$cost_i = \alpha + \sum_{k=1}^{n=6\text{-}1} \beta_k deductible_{ki} + \sum_{k=1}^{n=7\text{-}1} \theta_k age\_ki + \delta male_i + \sum_{k=1}^{n=3\text{-}1} \mu k income\_src_{ki} + \sum_{k=1}^{n=4\text{-}1} \lambda_k income_{ki} + \sigma oneperson\_hh_i + \sum_{k=1}^{n=59\text{-}1} \gamma_h healthplan_{ki} + \in_i \quad (5)$$

$$result_i = \tilde{\alpha} + \sum_{k=1}^{n=6\text{-}1} \tilde{\beta}_k deductible_{ki} + \sum_{k=1}^{n=7\text{-}1} \tilde{\theta}_k age\_ki + \tilde{\delta} male_i + \sum_{k=1}^{n=3\text{-}1} \tilde{\mu}_k income\_src_{ki} + \sum_{k=1}^{n=4\text{-}1} \tilde{\lambda}_k income_{ki} + \tilde{\sigma} oneperson\_hh_i + \sum_{h=1}^{n=59\text{-}1} \tilde{\gamma}_k healthplan_{ki} + \tilde{\in}_i \quad (6)$$

In model (5) $cost_i$ is the cost of enrollee *i* in 2012 and in model (6) $result_i$ is the risk-adjusted result for enrollee *i* in 2012. In both models, *deductible ki* is a dummy variable which is equal to 1 if enrollee *i* has chosen deductible category *k* in 2013 (leaving out category '000').

To control for possible heterogeneity in risk preference (i.e. risk aversion proxies), we included age dummy variables age_{ki} (7 categories), gender dummy variables $gender_{ki}$ (2 categories), income source dummy variables $income\_src_{ki}$ (3 income source categories: benefit-receivers, self-employed and a rest category), average household income variables $income_{ki}$ (4 categories) , one-person household dummy variables $oneperson\_hh_{ki}$ (2 categories). These variables are taken from the risk classes from the risk-adjustment system. See section 3 for a description of these variables. From the literature we know that there is a potential relation between gender, age, family status, income and occupation/education characteristics of individuals and their risk aversion (). However, note that the risk aversion proxies may also pick up other effects, such as health behavior or ability to pay. We have to keep this in mind when interpreting the effect of the risk aversion proxies on the estimations.

In both models dummy variable $healthplan_{ki}$ is equal to 1 if enrollee *i* has chosen healthplan *k* in 2013, which we added to control for potential unobserved factors that affect the risk-adjusted result and are related to the specific health plan that an enrollee has chosen in 2013. Lastly, α and $\tilde{\alpha}$ are the constants, and $\in_i$ and $\widetilde{\in}_i$ are the error terms.

In our estimation, we did not include all riskclasses that is used in the risk-adjustment system. Our goal is not to predict as well as possible the health care costs of each enrolee. However, we do want to control for enrollees' risk aversion, since, as discussed in section 4, there may be a bias in the OLS model if (*i*) the choice of deductible is related to risk aversion and (*ii*) risk aversion is related to enrollee cost type. It should also be noted that the risk-adjusted result is the residual of the risk-adjusted payment and costs. Therefore the risk-adjusted result has already been 'adjusted' for the effect of the observable consumer characteristics that are included in the risk-adjustment.

We estimated models (5) and (6) with the ordinary least squares (OLS). Table 6 shows the results of the OLS estimation of the cost model (5) and Table 7 shows the results of the OLS estimation of the risk-adjusted result model 6. For both models, we estimated the model in steps: (*i*) only the deductible dummy variables, (*ii*) adding health plan fixed effects and (*iii*) adding the risk aversion proxies. As with our descriptive analysis in section 5.2, we estimated the model using the dataset of enrollees who chose no voluntary deductible in the period 2010-2012.

Table 6 econometrically confirms our conclusions from the descriptive analysis in section 5.2: enrollees who chose a voluntary deductible in 2013 had significantly lower costs in 2012 than enrollees who did not choose a voluntary deductible in 2013. For example, in the model with only voluntary deductible dummy variables, enrollees who chose a voluntary deductible of €500 in 2013 had, on average, costs that were €1,661.50 lower in 2012 than enrollees who did not choose a voluntary deductible in 2013. We found similar effects for the other deductible categories (€100, €200, €300 and €400). Adding fixed effects only slightly reduced the estimated decreases related to the choice of a voluntary deductible in 2013. When the risk aversion proxies were added to the model, we found that the decrease in costs associated with a voluntary deductible is lower and that there is a increase in the R^2. However, the reduction in costs associated with having a voluntary deductible remains substantial. For example, enrollees who chose a voluntary deductible of €500 in 2013 had, on average, costs of €891.70 lower in 2012 compared to enrollees who did not choose a voluntary deductible in 2013.

Similarly, Table 7 confirms our conclusions from the descriptive analysis in section 5.2: enrollees who chose a voluntary deductible in 2013, had a significantly higher risk-adjusted result in 2012 than enrollees who did not choose a voluntary deductible in 2013. For example, in the model with only voluntary deductible dummy variables, enrollees who chose a voluntary deductible of €500 in 2013 had, on average, a risk-adjusted result in 2012 of €445.86 higher compared to enrollees who did not choose a voluntary

Table 6. OLS estimation of cost 2012 on deductibles 2013.

	Dependent variable: cost2012		
	(1)	(2)	(3)
Constant	2,261.756***	3,578.001***	3,391.542***
	(1.696)	(13.733)	(20.448)
deductible_2013 100	-1,490.718***	-1,270.968***	-669.262***
	(35.081)	(35.103)	(34.263)
deductible_2013 200	-1,618.965***	-1,482.874***	-852.448***
	(27.475)	(27.486)	(26.834)
deductible_2013 300	-1,608.693***	-1,491.396***	-871.760***
	(36.662)	(36.646)	(35.768)
deductible_2013 400	-1,634.726***	-1,514.096***	-957.012***
	(62.731)	(62.673)	(61.157)
deductible_2013 500	-1,661.473***	-1,412.512***	-891.700***
	(10.969)	(11.371)	(11.120)
age[30,40)			277.571***
			(6.258)
age[40,50)			134.474***
			(5.953)
age[50,60)			551.633***
			(6.079)
age[60,70)			1,365.584***
			(6.200)
age[70,70+)			2,834.631***
			(6.341)
male			-200.765***
			(3.277)
oneperson_hh			218.082***
			(4.455)
incomegroup1			-1,717.903***
			(15.044)
incomegroup2			-1,804.444***
			(14.865)
incomegroup3			-2,018.974***
			(15.066)
income_src benefitsreceiver			2,430.191***
			(5.772)
income_src selfemployed			-387.520***
			(7.473)
plan fixed effects	no	yes	yes
Observations	11,189,716	11,189,716	11,189,716
R^2	0.003	0.006	0.054
Adjusted R^2	0.003	0.006	0.054
Residual Std. Error	5,582.036	5,572.685	5,437.474
	(df = 11189710)	(df = 11189652)	(df = 11189640)
F Statistic	6,078.346***	1,081.476***	8,466.543***
	(df = 5; 11189710)	(df = 63; 11189652)	(df = 75; 11189640)

Note: * p<0:1; ** p<0:05; *** p<0:01.

Table 7. OLS estimation of risk adjusted result 2012 on deductibles 2013.

	Dependent variable: result 2012		
	(1)	(2)	(3)
Constant	-26.029***	-105.554***	-582.410***
	(1.447)	(11.730)	(17.893)
deductible_2013 100	312.270***	300.549***	345.379***
	(29.916)	(29.984)	(29.982)
deductible_2013 200	409.890***	403.887***	445.349***
	(23.429)	(23.478)	(23.481)
deductible_2013 300	431.057***	430.744***	469.269***
	(31.264)	(31.302)	(31.298)
deductible_2013 400	471.235***	471.247***	501.459***
	(53.494)	(53.534)	(53.516)
deductible_2013 500	445.857***	446.350***	475.240***
	(9.354)	(9.713)	(9.730)
age[30,40)			-15.396***
			(5.476)
age[40,50)			66.972***
			(5.209)
age[50,60)			104.224***
			(5.320)
age[60,70)			149.685***
			(5.425)
age[70,70+)			343.263***
			(5.549)
male			56.165***
			(2.867)
oneperson_hh			71.606***
			(3.899)
incomegroup1			391.714***
			(13.164)
incomegroup2			349.325***
			(13.008)
incomegroup3			309.668***
			(13.184)
income_src benefitsreceiver			-132.834***
			(5.050)
income_src selfemployed			55.798***
			(6.539)
plan fixed effects	no	yes	yes
Observations	11,189,716	11,189,716	11,189,716
R^2	0.0003	0.0003	0.001
Adjusted R^2	0.0003	0.0003	0.001
Residual Std. Error	4,760.164 (df = 11189710)	4,760.030 (df = 11189652)	4,758.072 (df = 11189640)
F Statistic	583.033*** (df = 5; 11189710)	57.188*** (df = 63; 11189652)	171.068*** (df = 75; 11189640)

Note: * p<0:1; ** p<0:05; *** p<0:01.

deductible in 2013. Again, we found similar effects for the other deductible categories (€100, €200, €300 and €400). Adding health plan fixed effects and risk aversion proxies only affect the results slightly.

7. DISCUSSION AND CONCLUDING REMARKS

Our empirical results point to the presence of selection under mandatory health insurance with open enrollment in a managed care setting. The uniquely rich dataset covering the entire population of the Netherlands over a period of several years allowed us to demonstrate the presence of the selection effect of deductibles separately from the potential moral hazard effect that arises simultaneously. From our analysis it follows that offering contracts with voluntary deductibles results in self-selection by healthier enrollees, who are overcompensated by the risk-adjustment system.

We observe the selection effect even after controlling for a large set of control variables for risk aversion, healthplan fixed-effects and possible other confounding effects. The expected gains on the risk-adjustment per enrollee with a voluntary deductible of €500 are estimated at around €450 on average. On top of this, the enrollee pays a larger share out-of-pocket, resulting in lower costs for the insurer to be reimbursed. In return, the insurer offers the enrollee a premium discount for taking a voluntary deductible.

It should also be noted that the literature on effects of voluntary deductibles shows that (*i*) enrollees are not always able to choose the optimal deductible options; (*ii*) enrollees are not always able to make the optimal choices in relation to these deductibles; (*iii*) there is little insight into the size of the reduction of the moral hazard effect on costs (because it is difficult to distinguish delayed costs from avoided costs and the reduction in excessive costs).

Thus, our paper provides convincing evidence that individuals have substantial private information that are not captured by the risk-adjustment system. When insurers have the possibility or obligation to diversify their health plans in terms of generosity, individuals can self-select into health plans. For health plan generosity in terms of deductibles, we show that this self-selection results in substantial differences in costs which are only partly compensated by the risk-adjustment system.

Given the substantial expected gains on the risk-adjustment for enrollees with a voluntary deductible, it is important to study in greater detail how the these gains are related to the premium discount for voluntary deductible that insurers set. For example, it would be interesting to determine if insurers are able to attract enrollees with large gains from risk-adjustment by offering large premium discounts. However, it may also be the case that by offering higher discounts the insurers may attract on the margin enrollees that are relatively high-risk. If we find that not all gains are translated into premium

discounts, it would be interesting to examine if this is due to the current regulation that stipulate that insurers are not allowed to differentiate the price discounts associated with voluntary deductible options between enrollees of the same health plans.

An option that the Dutch government could consider to fully eliminate the risk-adjustment gain of the deductibles is to include the choice of a voluntary deductible in the risk-adjustment system as one of the characteristics of the consumer. In this way, consumers with a voluntary deductible are not profitable any more in the risk-adjustment system, which decreases the incentive for selection. This may lead to a lower number of enrollees opting for a voluntary deductible. Consequently, the potential moral hazard effect would be lower too. Because this potentially results in a trade-off between improving solidarity (due to better risk adjustment) and cost reduction (due to moral hazard), more research in this area is definitely needed to understand the potential welfare effects.

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