Free drugs for children!
A study on fully subsidized prescription drugs for 17-year-olds in Sweden

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Abstract

This paper explores the effects of co-payment price reduction to zero for prescribed pharmaceuticals on the volume of medicine consumed and the price elasticity for youths. Data was collected from two Swedish national registries on pharmaceutical consumption and municipality socioeconomic factors for groups of ages 17 and 19, from January 2013 to June 2018. I use a difference-in-difference strategy to exploit the exogenous drop in January 2016 of medicine price for minors and if it differs between socioeconomic groups. The results show an association between zero price co-payment and increase of prescription drug use. Individuals living in high income municipalities increased their medical consumption with 15.2% while individuals living in low income municipalities increased their consumption with 14.5% due to the free drug reform. The price elasticity is greater for individuals living in high income municipalities, −0.120, than living in low income municipalities −0.110.

***Keywords* —** pharmaceuticals, co-payment, zero price, price elasticity, arc elasticity

Contents

1 Introduction

There is a vast amount of academic literature on the demand for prescription drugs and price elasticity. Papers on this topic have generally found a positive correlation between lower co-payment rate and increased medicine consumption. However, the magnitude of the change differs between groups depending on the health status and income level of the individual. The vast majority of these papers focus on the adult population and the elderly, few studies focus on minors. The demand that affects minors can be viewed as different since it is not only them who make sure they take their medicine, but also their guardians.

This paper focus on the exogenous price drop that occurred January 2016 when Sweden reduced the co-payment on prescribed medicine, for children from the age of 0 up until they turn 18. In this paper, I call this reform the Free Drug Reform and will use the abbreviation FDR. The purpose of this reform is to equalize health differences between socioeconomic groups.

The aim of this paper is to evaluate if a payment exemption on prescription pharmaceuticals has any effect on the volume of medicine sold at pharmacies to minors and whether this effect is different given different socioeconomic groups. A secondary purpose of this paper is to calculate and present price elasticities. The study is conducted on registry data from Swedish eHealth Agency and Statistics Sweden (SCB). It is based a panel data grouped by age, municipality and gender with monthly data from January 2013 to June 2018. Municipality income is also included as an approximation of socioeconomic conditions. To evaluate the effect on minors, it is needed to have treatment group and a control group with similar characteristics in health status and disease characteristics. For that reason, this paper uses 17-year-olds as the treatment group and 19-year-olds as the control group. The reason why 18-year-olds are excluded is because the data labels age per year, but in fact, they turn 18 during that year. Hence, the 18-year-olds' group contains both individuals in the FDR and individuals not in the fully subsidized system.

My analysis makes important contributions to the literature that relates price changes of medicine for minors and and their price elasticity. I find that change in cost sharing has an effect on prescribed medicine consumption. My estimates show that pharmaceutical consumption (measured in daily defined doses [DDDs] picked up from the pharmacy) increases from average level by 2,643 DDDs per 1,000 individuals (15.2% increase) for individuals living in high income municipalities. The increase in low income municipalities were estimated to 2,504 DDDs per 1,000 individuals (14.5% increase).

This study also contributes with an average price elasticity (arc) for 17-year-olds of −0.115. Implying that if prices increase by 10% the quantity consumed will decrease by 1.15%. Males have slightly higher arc elasticity, −0.151, than females, −0.100. These arc elasticities calculated for Swedish 17-year-olds are in the lower bound previous literature −0.33 to −0.12 (Joyce et al. 2002, Contoyannis et al. 2005, Gilman & Kautter 2008, Chandra et al. 2014).

This paper is organized as follows. Section 2 reviews prior research, connecting what previous studies has found to the contributions I aim to make. Section 3 is a brief summary of the background of the free drug reform and an explanation of the co-payment system in Sweden. Thereafter, section 4 covers data, how the sample is structured, descriptive statistics and motivating the use of the dependent variable daily defined doses (DDD). Section 5 covers the methodology of difference-in-difference and price elasticity and testing the parallel trend assumption. In section 6, I present the results of my findings. Section 7 contains the discussion. Finally, section 8 presents my conclusions.

2 Previous research

This section contains two focus areas of research on medical consumption and co-payment. Firstly, I start with addressing cost sharing and moral hazard, discussing the reasons for the co-payment system. Secondly, there is a presentation of price elasticitys for medicine. Each section ends with an explanation how this paper contributes to previous research.

2.1 Cost sharing and moral hazard

The general theory behind having co-payment is that free medicine would lead to moral hazard (over consumption of medicine) and this can be fixed with the correct level of co-payment.

The existing literature that explore effects of co-payment demand on pharmaceutical care among adults is vast. However, empirical studies on children's demand are very limited. It is important to make a distinction between empirical studies on adult and empirical studies on children due to some differences. One example is that the guardian of the minor is responsible for the child to get their treatments, hence, it is not only the child's demand for medical care but also the guardian's demand. Another important difference is that the change in co-payment for children effects the whole family budget, while a change in co-payment for adult affects households with and without children. Therefore, it is not only the child's price sensitivity that is of importance, but also its guardians.

A Swedish study on children's responds to small co-payments on healthcare utilization found an increase of care when it is free of charge. The study was conducted with individual level data and found that the increase of care was driven by those living in low income families. (Nilsson & Paul 2018)

Other studies examine the whole population and then study children as a subgroup. The American government conducted a large scale study on the utilization of medical care with health insurance, the RAND health insurance (Lohr et al. 1986). They randomly assigned insurances to families in USA and concluded that cost sharing reduced over-utilization but also had the effect of reducing needed care. They also studied children's response to co-payment and found that poor minors appeared to respond more than non-poor minors. However, this was not statistically significant for two main reasons. Firstly, the RAND health insurance suffered from small sample sizes when analysing this type of subgroups. Secondly, poor families had a lower co-payment maximum and would often receive free care for a considerable part of the year. Another study in the USA found that children's demand response is lower than adults (Ellis et al. 2017).

OECD (2011) conducted a literature study where they focused on cost sharing for prescription drugs. This was done due to that the structure for cost sharing on health care and the effect differs widely between countries. They found that cost sharing is a good policy tool to control for moral hazard of medicine. These results were true for both private health insurances and public health insurance. They stated that cost sharing helps to minimize moral hazard by decreasing over-use of high price drugs and improve the use of generic drugs (drug with the same active substances as the original medicine).

Literature on the adult population show that higher levels of cost sharing are associated with treatment disruptions (such as lower levels of treatment adherence, continuation, and initiation) for chronically ill patients (Gibson et al. 2005). Hence, higher levels of cost sharing can affect the use of essential medication and outcome of care. The same literature review by Gibson, et al. (2005) assessed effects of cost sharing on drug prescription. It was to determine if patients respond to increased cost sharing by replacing less costly medications with higher levels of co-payments. The results were that higher levels of cost sharing for prescription drugs decrease the consumption of prescribed medicine and steer patients towards preferred brand-name drugs.

Puig-Junoy et al. (2016) studied retired individuals and their medical consumption when reciving a zero price co-payment. They found prescription medicine on average to increase with 17.5%, due to the coinsurance exemption.

Leibowitz, et al. (1985) used data from the previous mentioned Rand Health Insurance Experiment and they found that when individuals pay less they buy more prescription drugs. A small study from California focused the effect of cost sharing increase on both pharmaceuticals and physician visits. They found similar results as the RAND Health Insurance Experiment for prescription drug use and medical doctor visits, increase in costs leads to decreased consumption (Chandra et al. 2010). They also found the opposite effect for the most ill population, and higher co-payment was associated with increase in hospital use.

Baicker and Goldman (2011) fond that cost-sharing can reduce use of both low-value and high-value services. Cost sharing have many effects that may go against each other; on one hand, bigger patient cost-sharing could reduce fiscal pressure from expansion of insurance by reducing the amplitude of moral hazard. On the other hand, there might be some evidence that low income patients can be more price sensitive than other patients or that low-income patients may be more likely to experience negative health effects from cost sharing.

Empirical studies on the adult population have found that changes in co-payments have different effects between income groups. This can be due to a numerous of reasons. First, low income patient may face a tighter budget constraint and therefore are more responsive to price changes, in other words, more elastic then high income individuals. This can lead to low-income patients cutting back on care where they have low marginal benefit. Second, Reeder and Nelson (2014) argue that since there is a high correlation between income and education, low income individuals may be less able to communicate with their physicians and, consequently, make less well-informed decisions. In other words, low income individuals may be less able to assess the marginal benefit of their care relative to higher income individuals. Hence, they might cut back on the high marginal benefit care. Goldman and Smith(2002) state that patients of lower socioeconomic status are less likely to follow a treatment routine for chronic illness. This results in worse health outcomes. Third, a higher rate of chronic illness among low-income populations can suggest different effects of cost-sharing. Commonly, studies focus on chronic illness and do not examine the correlation for low-income groups. In the previously mentioned study from Goldman et al. (2007), they conclude that increased cost sharing is highly correlated with reduction on pharmacy use. Since there seems to be different responses to change in co-payment between income groups, this paper will also try to see if there are different changes in consumption of medicine between socioeconomic groups.

As shown, several studies have found that change in co-payment have different effects between income groups. However, very few studies have examine this in the setting of children, hence, this paper aims to see if there are different changes in consumption of medicine between socioeconomic groups when the co-payment is free of charge. There is also a need to study the long term effects of the free drug reform, when enough time has passed so that these effects arises. It would be especially interesting to study persistence of early childhood investments on the younger children.

2.2 Price elasticity

Researchers have tried to study the effects of cost sharing of health insurance schemes on demand for medical care. They have calculated price elasticities to get a better understanding of individuals utility function and how price sensitive they are for health care and medicine. The earlier mention RAND health insurance conducted by Lohr, et al. (1986) also calculate price elasticity of demand. They found that individuals react to changes of the cost for health care and concluded a price elasticity of medical expenditures at -0.20 for the whole population. This means that an 10% increase in price leads to a 2.0% decrease in consumption.

Since then, others have also focus on the price sensitiveness for medicine. Alexander et al. (1994) conducted an empirical study using seven countries during 1980 to 1987. They found that variation in price and income across countries are important factors explaining the differences of pharmaceutical consumption across countries and time. This leads to that price elasticises differ between countries.

There has not been many studies on the price elasticity of prescription medicine in Sweden. Grandlund estimated the substitution reform where the pharmacists have to substitute the cheapest available generic product for the prescribed medicine. He found a price elasticity of −0.78 (Granlund 2010).

Researchers have found that price elasticity differ between different socioeconomic groups. The previously mentioned studies from California and Spain also calculated average price elasticity (arc). The estimate price elasticity of California is −0.16 for the low-income population and the arc elasticity for the elderly population in Spain was −0.13 (Chandra et al. 2010, Puig-Junoy et al. 2016). Studies from the latest two decades have a range of price elasticity of demand estimations on medicine costs from −0.33 to −0.12 (Joyce et al. 2002, Contoyannis et al. 2005, Gilman & Kautter 2008, Chandra et al. 2014).

As mentioned in the previous section, cost-sharing can be seen as a tool to influence pharmaceutical and hospital utilization. However, one aspect of the moral hazard issue is the medical care is more complex, it is not just a single good. For example, rising price for physician visits may make it less likely that patients receive prescription drugs. Since the health care system is dynamic and that some treatments have substitutes, optimal cost sharing depends not only on the own price elasticities, but also on cross-price elasticities (Goldman et al. 2007). For this study, I will only evaluate the price elasticity of prescription drugs and not examine cross-price elasticities.

Behavioural economics literature suggests that moving to a zero price model may be completely different from offering services at a price that is lower than before (Shampanier et al. 2007). Shapmanier et al. argue the zero pricing of a good does not only decrease costs but, individuals perceive extra benefits associated with a zero price.

There seems to be room for literature with focus on a decrease in the out-of-pocket burden for younger individuals. There also seem to be few examples of fully subsidized medicine for a larger group of the young population. This paper aims to give more knowledge of what happens with the quantity of prescription medicine when price goes to zero. I also aim to fill some gaps about the knowledge of price elasticity for young individuals.

3 Background

The Swedish Parliament decided that children from the age of 0 and until they turn 18 receive free prescription drugs starting 1 January 2016. This means that they do not have to pay any co-payment to receive their prescribed medicine, it is fully paid by the government.

The purpose of the FDR is to leveling out health differences between socioeconomic groups (Ministry of Health and Social Affairs 2014). The idea is that no child should have to forego drug treatment due to economic factors. One example of these socioeconomic differences is that individuals with an education higher than gymnasium live on average 5 years longer than individuals with an education up to gymnasium (National Board of Health and Welfare 2013).

The National Board of Health and Welfare in Sweden conducted a report of what type of drugs that had increased from 2016 to 2017 for minors. It seems as if medicine for allergies and cortisone ointment stand for a bigger increase of the quantity while ADHD medicine, asthma, sleeping pills and softening ointments stand for a larger part of the cost increase (National Board of Health and Welfare 2018). The report describes statistics but did not try to show much of the increase that was due to the reform. For further research, it would be interesting to analyze the effect of the price consumption for different types of medicine groups.

3.1 Swedish context

Sweden has a tax-subsidized health care system where the state pays the major portion of the medicine costs. The system has a high cost threshold for prescribed drugs. The patient's share of the cost of an outpatient drug and other eligible goods is called co-payment. The part paid by the government is called benefit. The drugs that are not included in the benefit is usually fully paid by the patient. (Vårdguiden 2018)

During 2013-2017, individuals had a co-payment cap of medicine costs up to $2,200$ Swedish kronor per year, the rest of the medicine costs were covered from the benefit (TLV 2018). After January 2018 the co-payment increased to $2,250$ Swedish kronor (National Board of Health and Welfare 2018). This was true for all Swedish inhabitants until the beginning of 2016. Since January 1st 2016, the government fully subsidize prescription drugs for individuals of the ages between 0 up until the day they turn 18.

One difference between explaining the pharmaceutical consumption females and males before the FDR are hormonal contraception. Historically, individuals under the age of 18 enjoy a zero price co-payment, in other words, they receive hormonal contraception for free. Individuals between ages 18 and 25 had a maximum price of co-payment of 100 Swedish kronor (SEK) per year, the rest is subsidized by the government. In January 2017 the regulation changed and the age limit for fully subsidized hormonal contraception increased from 18 to 20 (Swedish eHealth Agency 2017). The co-payment cap of 100 SEK still holds for individuals from ages 21 to 25 (Swedish Association of Local Authorities and Regions 2018). The county councils can choose to increase the age limit of fully subsidized contraception. Hence, my treatment group and my control group receive fully subsidized contraception.

As mentioned in previous research, another factor that influences the probability of a child receiving prescribed medicine is the cost of visiting a physician. The prescription medicine in the benefit is paid by the government, but the health care is operated and paid by the 21 county councils in Sweden. They receive income via the Swedish tax system. Physician visits are subsidized and almost every county council have a zero price for outpatient care for children under the age of 20. (Swedish Association of Local Authorities and Regions 2018)

4 Data

4.1 Sample construction

This study is based on data compiled from the Swedish eHealth Agency register and the Statistics Sweden (SCB) containing Swedish population of ages 17 to 19. To evaluate the effects of the price drop for minors on pharmaceutical consumption, a measurement of medical utilization have to be used. This can be measured in many ways: cost, number of units, number of prescriptions or by the physical quantity of drugs. But these kinds of measurements can fluctuate over time. WHO created defined daily doses (DDDs) and assign it per ATC code (Anatomical Therapeutic Chemical Classification System). The basic definition of DDD:

> The DDD is the assumed average maintenance dose per day for a drug used for its main indication in adults. (WHO 2018)

DDD is the best measurement in this study to analyse the quantity of medicine.

The secondary aim of this paper is to measure price elasticity for 17-year-olds. This is done by using DDD and out-of-pocket payment (OOP), a direct payments made by individuals, at the time of service use, to health care providers.

Both DDD and OOP are sampled from the eHealth agency. All companies that sell medicine in Sweden are required by law to report sales information regularly to the Swedish eHealth Agency, therefor the data contains all prescribed medicines that has been picked up from a pharmacy, and the co-payment cost for the individual. I have used this data that contains sales of prescribed medicine for outpatient care, measured in DDDs and OOPs. I observe each municipality DDD and OOP per 1,000 individuals grouped by age and gender over the time period of January 2013 to June 2018.

In this paper, I have used DDDs on prescribed medicine for outpatient care measured per 1,000 individuals.

I am interested in estimating the effect of the FDR between socioeconomic groups. Since the data used does not contain individual level data but aggregated data per municipality, an average yearly income for inhabitants of ages of 20 to 65 per municipality from Statistics Sweden (SCB) has been used as an approximation of socioeconomic characteristics. I created a high income dummy variable that takes the value one when the average municipality income for individuals are greater than the average of all 290 municipalities in Sweden. SCB has data of the municipality income during 2013 to 2016. I have used 2016 data as an approximation of socioeconomic factors for 2017 and 2018.

I have excluded 18-year-olds in all my regressions since the data contained ages per year. In other words, they are labelled 18 in the data but in fact are 17 during a portion of the year and therefore receive free medicine. Since individuals of age 17 and younger utilize the cost free medicine reform, I have defined individuals of age 17 as my treatment group. My control group contains 19-year-olds since they have similar characteristics as my treatment group, but are out side of the FDR. But, one of the biggest differences is that individuals of age 19 are classified as an adult and are responsible themselves, wile individuals of age 17 are minors and have a guardians taking care of them. This makes one likely difference, the guardian can help a 17-year-old to get their medicine while a 19-year-olds most likely collects it themselves. Another difference is that the guardian most likely pay for the medicine in the treatment group while the cost burden for medicines in the control group may be covered by their own income.

The merged data from the eHealth agency and Statistic Sweden contains grouped data per municipality and age divided by gender, hence, there is no information about the number of individuals but only data per 1,000 individuals. Each group is observed with monthly data between January 2013 to June 2018. The resulting data set includes municipality level data on the monthly number of prescription drugs sold from the pharmacies, out-of-pocket payment and high income dummy divided by sex and age.

My final analysis sample corresponds to 76,560 observations. It contains 290 municipalities during 66 months from January 2013 to June 2018. The data is grouped per gender, leading to 38,280 observations, and with two age groups (17 and 19) the data used contains 76,560 observations in total, as can be seen in table 1.

4.2 Descriptive statistics

Table 1 presents the main variables used in this paper. The mean monthly DDD are 16,536 per 1,000 individuals per month. The age variable contains of 17-year-olds and 19-year-olds. The gender variable is balanced, hence we have as many observations of female groups as we have of male groups. The high income dummy also presents that 35% of the municipalities have an average income above the national average.

Table 1: Descriptive statistics of main variables per 1,000 individuals

Variable	Obs	Mean	Std. Dev.	Min	Max
Monthly DDD	76,560	16,536	13,855	0	271,791
Age	76,560	18	1	17	19
Gender (female=1)	76,560	0.50	0.50	0	1
High income dummy	76,560	0.35	0.48	0	1
Monthly OOP	76,560	18,965.14	17,720.51	-12.163.04	342,343.8

Table 2: Yearly data of DDD and out-of-pocket payment per 1,000 individuals

	2015		2017		Percentage change	
	Treatment group	Control group	Treatment group	Control group	Treatment group	Control group
Nr of DDDs	163,634	169,202	211,180	188,975	29%	12%
Nr of DDDs High income	161,083	168,807	208,108	191,775	29%	14%
Nr of DDDs Low income	166,455	169,637	207,023	185,871	24%	10%
OOP (SEK)	304,078	293,127	0	256,434	-100%	-13%
OOP High income (SEK)	312,587	303,429	0	270,707	-100%	-11%
OOP Low income (SEK)	294,667	281,773	0	204,606	-100%	-15%

Treatment group is 17-year-olds and control group is 19-year-olds

Table 2 presents yearly data and percentage change of DDD and OOP grouped in socioeconomic factors in the municipality. In the mentioned report from the National Board of Health and Welfare, it is stated that almost 20% of all guardians does not know that children under he age of 18 get prescription drugs for free (National Board of Health and Welfare 2018). This would result in a delayed effect of the FDR. Due to that, table 2 compare data from 2015 with 2017, one year after the reform.

The medical consumption, nr of DDDs, have an increase with 29% for 17-year-olds from 2015 to 2017, while 19-year-olds have a 12% increase of medical consumption during the same time period, see table 2. The treatment group in high income municipalities have a greater increase in number of DDDs than the control group. The treatment group consume similar number of DDDs as the control group during 2015. After the free drug reform, the treatment group have a larger increase of DDDs than the control group.

The out-of-pocket payment for all and divided per income group are also shown in table 2. The treatment group's out-of-pocket payment have all dropped from 304,978 SEK per 1,000 individuals to 0 SEK due to the FDR. The OOP for the control group have dropped from 293,127 SEK to 256,434 SEK per 1,000 individuals (13% decrease) during the same period.

It is notable that the number of DDDs has increased for in the control group and the out-of-pocket payment decreases during the same time. This means that the medical consumption increases per person, while the number of individuals consuming medicine decreases. More individuals reach the co-payment cap of 2,200 SEK per year and consume more medicine without paying more.

5 Empirical strategy

5.1 Difference-in-difference model

To evaluate the relationship between free prescription drugs and the volume prescription drugs consumes for 17-year-olds in Sweden, I use a difference-in-difference model (5.1.1) time fixed effects and municipality fixed effects with monthly data from January 2013 to June 2018. The pharmaceuticals assessed are all prescription drugs for outpatient care with reimbursement in Sweden.

$$DDD_{it} = \alpha + \gamma Treated_i + \delta FDR_{it} + Sex_i + \lambda_t + u_i + \epsilon_{it} \tag{5.1.1}$$

Where DDD_{it} (defined daily dose) is the outcome of interest for municipality i and month t, α is a constant, $Treated_i$ is a dummy variable that indicates the treatment group (17 year of age), the free drug reform, FDR, estimator combines an indicator of being treated and a dummy for being in the post-treatment period, which starts at time January 2016, Sex_i is a dummy variable indicating the gender (female = 1 and male = 0) grouped in the municipality i, λ_t is a time fixed effect, u_i denotes municipality fixed unobserved heterogeneity, and ϵ_{it} is a random error term.

In this model, the effect of free medicine is identifying by δ, it measures the change in the outcome defined daily doses (DDDs) for youth at the age of 17 relative to those who do not get fully subsidised prescription drugs (19-year-olds).

The previous research have found that the price elasticity of demand differ between socioeconomic groups. To estimate the DRF effects between socioeconomic groups in this paper, regression 5.1.1 is conducted separately on hing income group municipalities and on low income group municipalities

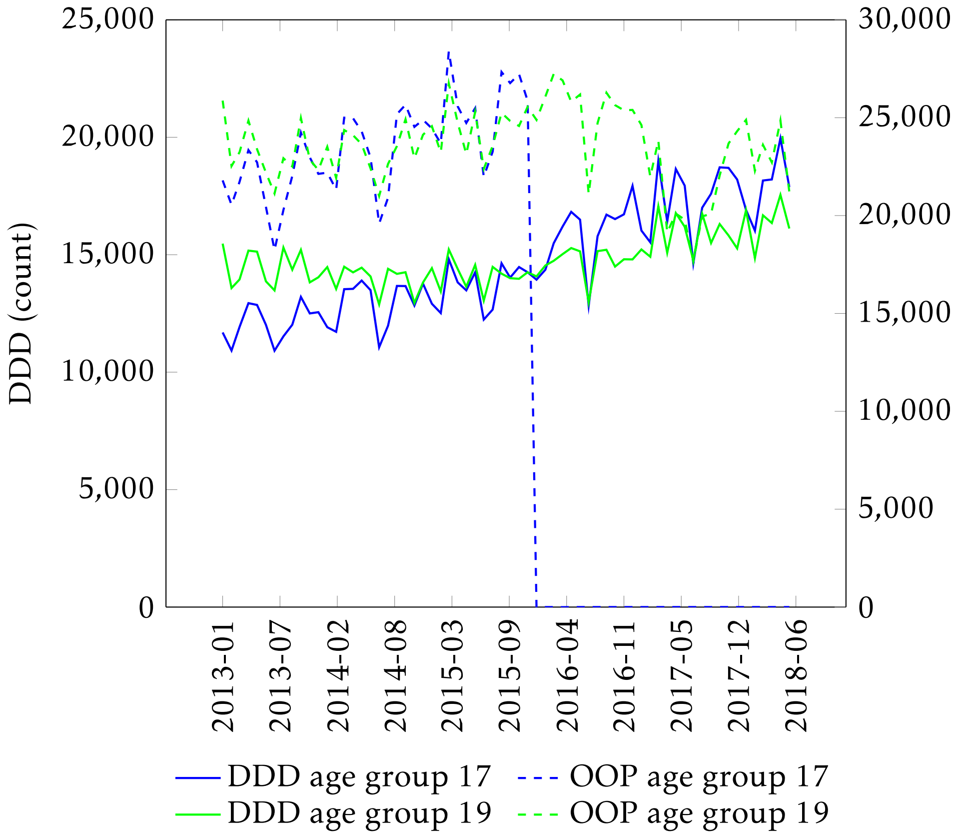
5.1.1 Parallel trend assumption

One central element for a difference-in-difference estimation is that the trend should be parallel between the control and treatment group pre-intervention. This common trend assumption implicates that the trend of getting prescription drugs should have been the same for the treatment group and control group in the absence of the free drug reform for children. There are two main ways to study the parallel trend assumption, one is visually and the other one is with using placebo interventions.

Firstly, I test the parallel trend assumption by plotting DDD, figure 1. The figure show monthly DDD and OOP per 1,000 individuals where 19-year-olds have a higher consumption of medicine relative to 17-year-olds. The parallel trend is not clear from the figure, but, an effect from the FDR can be seen on the treatment group.

Secondly, I conducted two regressions with placebo interventions for the treatment group. One placebo dummy (Placebo reform 1) starts at January 2015 and ends in December 2015. The other placebo dummy (Placebo reform 2) started in January 2014 and ends in December 2015. If the placebo dummies are significant then there is a violation of the parallel trend assumption.

Figure 1: Monthly DDD and OOP per 1,000 individuals



5.2 Price elasticity

A classic price elasticity measures a point, so called point elasticity of demand. But, since one of the prices are zero I have used the average price elasticity (arc) to asses the elasticity of demand. Arc measures the midpoint between the two selected points, price P and quantity Q. The arc calculates the percentage change in P and Q relative to the average of the two prices and the average of the two quantities as model 5.2.1 shows.

$$\epsilon = \frac{\frac{P_1+P_2}{2}}{\frac{Q_1+Q_2}{2}} \times \frac{\Delta Q}{\Delta P} \tag{5.2.1}$$

P_1 is the total out-of-pocket payment per $1,000$ individuals in year 2014 and P_2 is the OOP in year 2017. Q_1 is the sum of DDD per $1,000$ individuals in year 2014 and correspondingly Q_2 is the amount of DDDs in 2017.

I calculate arc elasticities per municipality and use the high income municipality dummy to compare elasticities between high income municipalities with low income municipalities. Note that the price elasticity is calculated on yearly data.

This model is sensitive to the range between the two points and how curvature the actual demand curve is. This is due to that formula assumes the section of demand curve between two points is linear.

6 Results

This section is divided into three sections. The first presents the main estimates of regression 5.1.1. The second one investigates the average price elasticity of demand. Finally, the third section is robustness check of the results.

6.1 Main results

The main result of the FDR's effect on socioeconomic groups estimated with regression 5.1.1 are shown in table 3. Column (1) estimate effects of the FDR on DDD per $1,000$ all individuals in all municipalities, secondly column (2) estimates only high income municipalities and the third column (3) is a regression only on low income municipalities.

Table 3 regression (1) show the estimated impact of the free drug reform for 17-year-olds on DDD and the result is highly significant. A decrease in the out-of-pocket expenditure to zero and individuals will increase their medical consumption to 2,563 daily defined doses per $1,000$ individuals, this correspond to a 14.6% increase. This result that a decrease in the co-payment for prescription medicine increases the consumption is intuitive and in line with previous research.

It can be noted that the treated group (17-year-olds) have 1,633 lower monthly DDDs consumption per 1,000 individuals than the reference group (19-year-olds). This difference is in line with the descriptive statistics in table 2.

Table 3 regression (2) contains estimation on the effects of FDR in high income municipalities. It shows an increase of 2,643 DDDs per 1,000 individuals due to the FDR. This is an increase of 15.2%, slightly higher than the average of all municipalities. The low income municipalities ware presented in regression (3) and had an estimated effect of the FDR on pharmaceutical consumption of 2,504 DDDs per 1,000 individuals. Corresponding to an increase of 14.5%. From this result, it seems as individuals living in high income municipalities increased their medicine consumption the most due to the free drug reform. The results are all significant on a 1% level.

The results from table 3 means that, on average, one individual increase their consumption with 2.56 DDDs per month due to the free drug reform. In high income municipalities, this volume is close to 2.64 DDDs and in low income municipalities, the average monthly consumption per person is estimated to be 2.50 DDDs.

Another interesting finding is that the high income group consume more prescribed pharmaceuticals than the low income group, regardless of the free drug reform.

Table 3: Base regression on monthly DDD per 1,000 individuals grouped by whole all municipalities, high income municipalities and and low income municipalities

VARIABLES	(1) DDD All	(2) DDD High income	(3) DDD Low income
FDR	2,562.667***	2,642.785***	2,504.486***
	(145.132)	(197.509)	(205.299)
Treated group	-1,633.478***	-1,953.168***	-1,401.322***
	(89.620)	(123.859)	(125.800)
Gender (female=1)	18,687.767***	18,285.674***	18,979.762***
	(71.289)	(97.234)	(100.732)
Constant	6,817.598***	7,160.281***	1,774.677***
	(300.169)	(302.996)	(380.911)
Observations	76,560	32,208	44,352
R-squared	0.496	0.547	0.467
Municipality FE	YES	YES	YES
Time FE	YES	YES	YES

Cluster robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Regression per gender and municipality income, monthly DDD per 1,000 individuals

	Female			Males		
	(1)	(2)	(3)	(4)	(5)	(6)
	DDD	DDD	DDD	DDD	DDD	DDD
VARIABLES	All	High income	Low income	All	High income	Low income
FDR	3,647.733***	3,755.401***	3,569.546***	1,477.600***	1,530.168***	1,439.426***
	(265.428)	(356.162)	(378.053)	(102.068)	(146.096)	(140.590)
Treated group	-3,987.659***	-4,559.440***	-3,572.436***	720.702***	653.104***	769.791***
	(164.674)	(224.664)	(232.677)	(58.901)	(84.063)	(81.267)
Constant	25,129.540***	25,390.961***	16,357.077***	7,193.423***	7,215.275***	6,172.039***
	(503.865)	(524.940)	(348.734)	(267.623)	(265.919)	(176.659)
Observations	44,352	22,176	22,176	32,208	16,104	16,104
R-squared	0.467	0.100	0.135	0.547	0.144	0.166
Municipality FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES

Cluster robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In table 3, there are significant differences of consumed medicine between the genders in all three regressions. Where women consume 18,628 DDD per 1,000 individuals more in one month than males. This can be due to that some women consume hormonal contraception, hence, increases the DDDs consumed before the FDR relative to the men.

In the light of this difference, it is interesting to know the effect of free prescription drugs on the monthly consumed doses between females and males. Hence, I conducted separate regressions per gender and socioeconomic conditions, table 4. The results are highly significant for both females and males.

Table 4 column (1) show the FDR on females in all municipalities. Females increased on average with 3,644 numbers of DDDs per 1,000 individuals, (14.0% increase). Males increased with 1,481 DDDs per 1,000 individuals (15.6% increase), table 4 column (4). It can be noted that the increase is granter for females in absolute numbers but males have a larger increase in terms of percentage. This is due to that females consume more pharmaceuticals per month (on average 28,988 DDDs per 1,000 individuals) than males (on average 9,481 DDDs per 1,000 individuals).

6.1.1 Robustness checks

I asses the plausibility of a common trend pre January 2016 with two placebo reforms. I test the common trend assumption in table 5 using placebos reforms as describes earlier.

The first regression (1) includes a dummy variable for a placebo reform during January to December 2015. The second placebo (2), is a placebo reform during January 2014 to December 2015. If the placebo reforms are significant then there is a violation of the parallel trend assumption. Unfortunately, both placebo tests are significant which means that the parallel trend assumption is violated. They were also significant when including control variable for municipality income and conducting them in municipality income subgroups. I conducted robustness checks with placebo reforms per socioeconomic group and gender. The results were still significant at a 10 percent level. This may lead to bias the results. However, since the coefficients in table 5 are in the same direction as in the tables 4 and 3, this means that the magnitude of the effect is uncertain. Therefore, it shows that FDR has an increasing effect on pharmaceutical consumption.

To address this problem of possible endogeneity in the DDD variable, I would need to use an instrumental variables approach. For this strategy to be successful, the instrument needs to fulfill two conditions; it has to be correlated with the endogenous regressor (FDR) which I aim to treat, but uncorrelated with the outcome variable (DDD).

Table 5: Test of common trend assumption, DDD per 1,000 individuals

VARIABLES	(1) DDD	(2) DDD
FDR	3,080.181***	3,711.692***
	(156.468)	(186.658)
Placebo reform 1	1,552.542***	2,184.053***
	(194.471)	(219.495)
Placebo reform 2		1,263.023***
		(213.881)
Treated	-2,150.992***	-2,782.504***
	(107.007)	(147.679)
Gender (female=1)	18,687.767***	18,687.767***
	(71.262)	(71.249)
Constant	6,817.598***	6,817.598***
	(302.020)	(300.076)
Observations	76,560	76,560
R-squared	0.496	0.496
Municipality FE	YES	YES
Time FE	YES	YES

Cluster robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6.2 Price elasticity of demand

I estimate average price elasticity of demand for each municipality and per gender grouped in high and low income municipalities. The elasticity for the median municipality is -0.115, see table 6. This implies that if price increases with 10 percent, then medical consumption decreases with 1.15 percent.

Table 6 shows that individuals seems to be more elastic in high income municipalities than low income municipalities. High income municipalities have an average elasticity of -1.20 while low income municipalities have an average elasticity of -0.110. Both elasticises are similar in the magnitude and both can be consider as relatively inelastic. Bigger differences between high and low income municipalities can be found between men. Men in high income municipalities are more elastic with

Table 6: Price elasticity for co-payment on prescription medicine, on age group 17

Median elasticity per group	All	Female	Male
All municipalities	-0.115	-0.100	-0.151
Low income	-0.110	-0.106	-0.129
High income	-0.120	-0.099	-0.163

an arc elasticity of −0.163, while men in low income municipalities have an average arc of −0.099. This implies that a 10% increase of the price, decreases the medical consumption with 1.63% for men in high income municipalities and 0.099% in low income municipalities. Women's elasticity are all close to −0.1. Hence, there seems to be small differences in elasticity between income groups. The results are in the lower range of previous estimates that can be found in the literature review.

7 Discussion

In this paper, I have evaluated the effects of a drop in the co-payment of prescription drugs on the volume of medicine picked up from pharmacies in Sweden. This was conducted with a difference-in-difference approach where the treatment group were Swedish 17-year-olds and the control group were 19-year-olds. The time for the free drug reform to be executed were 1st of January 2016.

The results show an association of the free drug reform and increased consumption of prescription drugs. On average, the FDR increased individuals pharmaceutical consumption with 14.6%, this is slightly smaller than the 17.5% to be found in the previously mentioned paper by Puig-junoy et al. (2016). The studied increase was found to be vaster among high income municipalities relative to low income municipalities. The result show an average increase of 2,504 DDDs per 1,000 individuals for minors living in high income municipalities, corresponding to an increase of 15.2%. However, low income municipalities have an average increase of 2,643 DDDs per 1,000 individuals, a slightly smaller increase of 14.5%. This is similar to previous studies on the adult population (Puig-Junoy et al. 2016).

This may not be intuitive at the first glance. One might think that they already buy what medicine they need when having money. But, one main reasoner for the free drug reform to have an effect is that custodians or the child needs to know about the reform. The previously mentioned report from The National Board of Health and Welfare (2018), also conducted a survey that showed that only 44% of custodians with children of ages 0 to 17 believe that all types of drugs for minors are free of charge. In the same report, they also state that there is an association of having a higher income and knowledge about the reform. The same is true for having higher education and knowledge of the FDR. Income is highly correlated with high education and the knowledge about the reform might be one reason I found that higher income municipalities reacted more to the FDR.

Another finding is that the effects of FDR on prescription drug consumption is associated with greater percentage change for males (15.6%) than for females (14.0%). This is the case on regressions on the whole population and with grouped per income, see table 4. One reason that females does not have the same increase of DDDs due to the FDR might be that they already had a part of their medicine fully subsidized, namely hormonal contraception. As women consume contraceptives for free, some of the need for free drugs has already been filled. However, men received the benefit of free drugs through the FDR.

The results that show a gender difference are not intuitive. Why should men consume more medicine, measured in percent, than women when they are for free? And why do women on average consume 3.5 more DDDs per person and month due to the FDR? This result need further studies on which drugs drives this increase.

One interesting finding in section 4.2 Descriptive statistics is that the control group increases in the number of DDDs per 1,000 individuals between 2015 and 2017, and during the same time period decreases the OOPs per 1,000 individuals. This is a very interesting result and would need more detailed data to conduct a deeper analysis on the number of individuals consuming pharmaceuticals. If one have individual level data and data on what types of medicines that increases the most, deeper analysis of the free drug reform can be made in the light of medicine groups.

In this paper, the arc price elasticity of pharmaceutical costs are in a range from −0.163 to −0.099. This result is in the lower bound of previous literature, −0.33 to −0.12 (Joyce et al. 2002, Contoyannis et al. 2005, Gilman & Kautter 2008, Chandra et al. 2014, Puig-Junoy et al. 2016). There are several reasons why they differ. The previous estimates are usually made on adults and elderly individuals, mine are of minors. Adults may be more price sensitive when buying medicine to themselves than when they buy medicine to a 17-year-old child. The country context differ, Sweden had a co-payment maximum of 2,200 SEK per year which can be seen as low, this can effect that my results are in the lower bound of previous literature. Hence, this estimates of price elasticities for Swedish 17-year-olds are not an universal for the Swedish population, more research can be made in this area.

The most inelastic price elasticity found in this paper was among females in low income municipalities, −0.099 and the most elastic was among males living in high income municipalities, −0.163. There is no clear reason for this and further studies could be made on elasticity for minors in different socioeconomic groups.

One aspect of the medical consumption was not only the price elasticity but also the cross price elasticity. As mentioned in previous research, Baicker and Goldman found that change in price of physician visits have an effect on the medicine consumed (2011). My treatment group and control group have the same price for physician visits and have had the same price changes. Due to this, the cross price elasticity of a physician visit wont be a matter when estimating the medical consumption with a difference-in-difference model.

The empirical strategy used in this paper has one main flaw, the parallel trend assumption. I conducted robustness checks with 2 placebo tests. They could not prove a parallel trend before the FDR, which is of importance for a difference-in-difference analysis. There are two main reasons that the results of the FDR effects on DDD still holds. Firstly, it is still intuitively plausible that some individuals did not get their prescribed medicine before FDR due to the co-payment cost and therefore the medical consumption would increase with a free drug reform. Secondly, Table 3 and 4 show highly significant and similar results on the effect of free medicine reform for children. This give some evidence that the reform affect medicine outtake from the pharmacies but the results are not conclusive. The placebo test may not hold and therefore the magnitude of the FDR should be interpreted with care, but due to the two above reasons, one finding is that free prescription drugs increases the medicine consumed. However, the result that individuals living in high income municipalities react greater to the FDR than individuals living in low income municipalities are not conclusive.

There are some weaknesses with using aggregated data. One limitation of this study is that since the data is on a municipality aggregated level, I have not been able to control individual characteristics, e.g. the individual's state of health. But with individual data, one can control for some individual specific effects and conduct a socioeconomic analysis. A second limitation is that I can not rule out that the increase of DDDs might be due to physicians willingness to prescribe more when they know that minors does not have to pay for the medicine. In this study I have analyzed the number of DDDs that individuals pick up at the pharmacy, not the number of prescribed medicine. To be able to control for the prescription rate, one would also need data on the actual amount of prescribed medicine. A third limitation of this paper is that the price elasticity is estimated per municipality but previous research have shown that elasticity depends also on the consumer health. There is an association between more severe health problems and an inelastic price elasticity.

Since Sweden is an exemption in the world for fully subsidize prescription drugs for minors, it will be interesting to see if there are long term effects on children's health status due to the FDR. Further studies should be conducted to analyze the short term and long term effect on socioeconomic groups. Due to the Swedish tradition on registry data, this can be done in the future when long term effects starts to show.

8 Conclusion

The main conclusion of this paper is that there exists an association between zero co-payment of prescription medicine and increase of pharmaceutical consumption. However, the underlying assumption of a parallel trend for the difference-in-difference model was not proven and therefore, the results are not conclusive. Other findings were that there seems to be different magnitudes of response to the FDR between socioeconomic groups. Due to that the data is grouped and not individual level data, further research should be conducted to validate the results.

Estimated average price elasticities were in the lower bound of previous studies. They showed a small relationship between higher income and increased price sensitivity. However, it seems that Swedish 17-year-olds are not particularly price-sensitive. This could be because the custodians are involved and create the demand that affects a child's exhaustion of medicine.

Future studies can be conduced to evaluate the effects of free drugs for minors depending on their health status and socioeconomic factors. Other studies can also focus on if the FDR effects different between medicine groups. More studies is needed on the demand of pharmaceuticals for minors, the literature is very scarce. There is also room to study the costs of free prescription drugs relative to its effects. Finally, future studies should also focus on the long term effects of free prescription medicine for minors.

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