The Zero-Price Effect Using Field Data: An application to the market for generic pharmaceuticals[•]

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Date: This Draft, Sep 17, 2018

Abstract

We use Swedish data on 310,000 consumer choices of medically equivalent drugs to study the zero-price effect (Shampanier et al. 2007) in a non-experimental setting. The Swedish benefit scheme implies that, during a given month, all consumers face the same price-differences between generic substitutes and that about a fifth of the consumers pay a zero price if they choose the cheapest substitute. Using both regression discontinuity designs and discrete choice models, we find no evidence for a zero-price effect in our study.

Keywords: Zero-price effect; free; behavioral pricing; pharmaceuticals; prescription drugs; generic drugs

JEL codes: D12; D90; I11; I13; M31

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[•] A research grant from Jan Wallander and Tom Hedelius foundation and Tore Browaldhs foundation (project number P2016-0113:1) is gratefully acknowledge. We are also grateful to the County Council in Västerbotten for supplying the data used in this article and to seminar participants at Umeå University for helpful comments and suggestions.

1. Introduction

In an experimental setup, Shampanier et al. (2007) find intriguing experimental evidence of a zero-price effect, i.e., they find evidence consumers attach significantly higher benefits to products at zero price and it cannot be explained by standard cost-benefit analysis. However, they note that "[…] it remains an open question whether the zero-price effect occurs when the decisions involve larger sums of money and more important decisions." (Shampanier et al., 2007, p. 754). Our paper addresses this open question using Swedish register data on purchases of pharmaceutical prescription drugs.

From a practical perspective, the zero-price effect is important to study since zero copayments and zero coinsurance rates in insurances is used and possibly can be an effective tool to affect consumers' choices. For example, the Affordable Care Act requires new health plans to offer certain preventive services at no cost and some Medicare Part D prescription drug plans offer generics without coinsurances, i.e. without out of pocket costs (Hoadley et al., 2012). Knowledge about the zero-price effect and state dependence is also important from a marketing perspective, e.g. to predict the long-run consequences of offering free trials.

Also from a theoretical perspective, it is interesting to study the zero-price effect. According to standard consumer theory a consumer will choose the option with the highest cost-benefit difference when making a choice. That is, when choosing between goods Y and X, Y will be chosen if $V_Y - P_Y > V_X - P_X$, where V_i and P_i denote the consumer's valuation and the price of good *i*, respectively. Now, assume that $P_X < P_Y$ and that both prices are reduced by the amount P_X, i.e. the prices change from $[P_X, P_Y]$ to $[0, P_Y - P_X]$. A zero-price effect has occurred if a consumer, who without the price cuts would have chosen Y, now chooses good X. This implies that the zero-price of good X induces some additional value α to the good, i.e., now $V_Y - (P_Y - P_X) < V_X + \alpha$.

Shampanier et al. (2007) find evidence of a positive α through a series of experiments. Their experiments are based on hypothetical as well as real choices of different chocolates, and Amazon gift cards, and for hypothetical choices about flat-panel televisions. After they established the zero-price effect they provided three different psychological explanations for the effect: social norms (free goods may invoke norms of social exchange as compared to market norms), mapping difficulty (people may have difficulty mapping the utility they receive from consumption into monetary terms) and affect (options with no

downside can invoke positive affective behavior). Their results are consistent with affect being the main cause for the zero-price effect.

Hossain and Saini (2015) confirms the result of Shampanier et al. (2007) for the hedonic[1], affect-rich, goods chocolate by asking students to make hypothetical choices in an online study. However, they found no zero-price effect for packed sugar which they view as utilitarian, affect-poor, goods. These and other results of Hossain and Saini suggest that the zero-price effect primarily affect the choice among hedonic products. Since prescription pharmaceuticals clearly can be viewed as utilitarian goods, it is not clear if we would find zero-price effect.

Nicolau and Sellers (2012) found a zero-price effect in an experiment where participants made hypothetical choices among hotels, with or without breakfast, and where the price of breakfast on the cheaper hotel was reduced to zero. That is, the zero-price effect can also apply to multicomponent contexts where consumers still must pay a positive price for one component, in their case the room. Also Baumbach (2016) found evidence of a zero-price effect in a multicomponent experiment, but she did not find a statistically significant zero-price effect in a high-price single component context, possibly because of relatively small sample sizes.

However, all of these studies test the zero-price effect in experimental settings. To our knowledge, our study is the first which uses field data to test the zero-price effect. In our setting, the Swedish benefit scheme for prescription drugs provides an opportunity to study the zero-price effect using field data. For drugs included in the scheme, a reference price is set equal to the price of the cheapest available substitute product. Consumers pay a share of this reference price, plus the entire price difference if they choose a more expensive product. The share paid of the reference price is decreasing in the consumer's accumulated expenditure within the benefit scheme during a 12-month period. In the first coinsurance bracket, consumers pay 100% of the reference price, then 50%, 25%, 10%, and finally 0% in the last coinsurance bracket. Irrespective of coinsurance bracket, consumers choosing another product than the cheapest one pay the full price-difference. Hence, consumers in the 0% bracket face the same price difference between substitute products as other consumers, but for them the price of the cheapest product is zero. More importantly, manufacturers need to go through a price bidding process each month. Not knowing what bid their competitors will submit, the uncertainty of the bidding process introduces randomness about which generic

[1] See Khan, Dhar, and Wertenbroch (2005) about classification of good and services as hedonic or utilitarian.

drug is the lowest price product of the month. Intuitively, for consumers who are in the 0% bracket, which drug they pay zero price could change from one period to another. Moreover, consumers who are in the 10% bracket pay very low price (close to zero) to obtain the cheapest price generic drug. Furthermore, consumers who have just to reach the accumulated-expenditure threshold for the 0% bracket should be similar to those in the 10% brackets that are close to reaching the threshold. The institutional setting provides us with the data variation to test for a zero-price effect using both regression discontinuity designs and discrete choice models.

A priori, we expect that the zero price effect should be very significant in this market. This is because generic drugs are certified to be bio-equivalent. Hence, we expect generic drugs should have very little horizontal differentiation. Unlike the previous studies which always test products with different vertical quality level, the true quality of generic drugs should be much closer to each other. Generic drugs also hardly use advertising to create brand loyalty. Descriptive statistics show that the market share of buying the cheapest product is indeed significantly larger in the 0% coinsurance bracket than in the 10% bracket, which is consistent with a zero-price effect. However, a regression discontinuity setup based on 310,000 prescriptions close to the cut-off between the 10% bracket and the 0% bracket, shows that this difference is caused by the share increasing continuously in the consumer's accumulated expenditure. This correlation could be caused by accumulated expenditure being correlated with factors like age, health and consumption history, which in turn affect the preference for different products. Finally, estimations of discrete choice models controlling for observed and unobserved heterogeneity show that the probability to buy the cheapest product is not significantly larger for consumers who get this product for free.

The paper is structured as follows. In the next section, we describe the institutional settings for the prescription drugs in Sweden, while Section 3 presents the data including comparisons of market shares across coinsurance brackets. In Section 4 we describe our regression discontinuity setup and present the results from this analysis. Then, Section 5 displays the empirical specification and results for the discrete choice modelling. Finally, our conclusions are presented in Section 6.

2. Institutional Setting

All Swedish residents are covered by a mandatory and uniform pharmaceutical benefit scheme. For costs included in the benefit scheme, a consumer pays 100% up to and including

1,100 Swedish crowns (SEK, approximately USD 124) of accumulated expenditures within the benefit scheme for all her drugs during a 12-month period and we refer this to bracket 1. Then, the consumer pays 50% of the cost in the second bracket ranging from SEK 1100 to 2098.8; 25% from 2098.8 to 3900.6 in bracket 3; and 10% from 3900.6 to 5398.8 in bracket 4, and thereafter the consumer is in bracket 5, where the coinsurance rate is zero. These figures are for 12-months periods starting 2013-2016 and the uneven number is the consequence of that the values, since 2013, are related to an index. The widths of coinsurance brackets were nearly identical for 12-months periods starting in 2012, but lower before that.[2]

A generic substitution regulation requires pharmacy personnel to inform consumers whether cheaper substitute products are available. The obligation is waived if the physician indicated on the prescription that no substitution should be allowed for medical reasons or if the pharmacist has reason to believe that the consumer would be adversely affected, e.g., because the low-cost alternative has a package that is difficult to open for some. Physicians and pharmacists only opposed substitution for a few percentage points of the prescriptions and in these cases the entire cost of the prescription is included in benefit scheme and subject to the coinsurance rates described above. If consumers choose to buy another product instead of the cheapest available, the entire addtional cost will be charged to them.

Only products within narrowly defined exchange groups, which have the same combination of active substance, form of administration, and strength, and nearly identical packet size[3], are considered substitutes. Thus, consumers choose between bioequivalent products, but the drugs can include different inert ingredients and differ in color and shape. Olsson et al. (2015) report that 29 percent of the consumers in Sweden have low trust in the bioequivalence of exchangeable products and Granlund and Rudholm (2012) reported that 17% of consumers that was not prescribed the cheapest product paid extra to avoid substitution to this product. These results show that at least some consumers do not consider exchangeable products to be identical.

In 2009, the interpretation of lowest-cost available generic was changed from the lowest-cost product *at the local pharmacy* to the lowest-cost product *in the market as a whole* (i.e., in Sweden). To allow pharmacies to clear excess inventory, pharmacies are also

[2] For 2012, the differences were that the 25% and 10% brackets were for costs between SEK 2100 and 3900, and 3900 and 5400, respectively. For insurance periods starting April 1, 2003- December 31, 2011, consumers paid all cost up to SEK 900 per 12-month period, 50% of the cost for SEK 900-1700, 25% for 1700-3300, and 10% from SEK 3300-4300.

[3] Packet size is allowed to vary slightly; for example, substitution will be made from a 30-pill package to a package in the 28–32-pill range.

allowed to sell the product that was cheapest in month $m-1$ during the first 15 days of month m without additional cost to the consumer (Dental and Pharmaceutical Benefits Agency, 2009).

Firms wanting their product to be included in the pharmaceutical benefit scheme must submit their price bids for month *m* to Dental and Pharmaceutical Benefits Agency (DPBA) in month *m-2*. Firms bid in prices that are uniform across Sweden and include transport to the pharmacies. Prices not exceeding the highest price within the exchange group the previous month are always approved by the DPBA. During month *t-1*, DPBA announces all purchase prices and the retail pharmacy prices, which are set with a simple algorithm that to the purchase price adds a margin that is continuously increasing in the pharmacy purchase price. At the same time, DPBA also announce which products that have the lowest price per pill in their exchange groups and hence should be sold without additional costs to the consumers. It can be profitable for firms that want their product to be the lowest-cost product to apply mixed pricing strategies in order to make it hard for competitors to predict their prices. 38% of generic products have a different price than the preceding months and the price differences are often large (Granlund and Bergman, 2017). 80% of the products in our sample were the lowest-cost product at least one month.

The rules of the benefit scheme imply that additional cost, caused by consumers not choosing the cheapest available product, does not count towards the cut-off points that determine the coinsurance bracket. Therefore, consumers' choices between substitute products do not affect which bracket the consumer is in. However, if they choose not to fill a prescription, it may delay their transition to brackets with lower coinsurances. The coinsurance rates are also related to the general health status of the consumers, since those with relative good health are more likely to receive only a few prescriptions per year. Therefore, they are less likely to reach the zero-coinsurance bracket.

3. Data

The data used in this paper is provided by the County Council in Västerbotten, Sweden. It contains 2,981,745 observations of non-narcotic pharmaceuticals filled by adult inhabitants of the county of Västerbotten from September 2010 to December 2013 that are exchangeable according to the Medical Product Agency and for which there is no uncertainty about which exchange groups products belongs to. We exclude 3,186 observations in exchange groups and month where no product is sold in the first 15 days of the month and drop 41,517 observations

where the consumer is not identified, since we cannot calculate the consumers' positions in the benefit scheme for these observations.[4] Then, we exclude 928,747 prescriptions that are for individualized dosage bags. 75% of these prescriptions are for consumers 75 years old or older and each bag contains all pharmaceuticals that a particular individual need to consume at one specific time. We also exclude 59,549 prescriptions when physicians and 60,740 prescriptions when pharmacist opposed substitution, since consumers have no choices in these cases. Finally, excluding 5,164 prescriptions with a possible error in the accumulated expenditure exceeding SEK 5, leaves us with 1,882,842 prescriptions in 606 different exchange groups and 15,096 exchange group*month combinations.

Table 1 shows the prescriptions in the final sample are distributed over different coinsurance brackets. Here, the 0% bracket is divided in three parts: brackets 5a, 5b and 5c containing consumers with, respectively, less than SEK 2000, SEK 2000 to SEK 4000, and more than SEK 4000 of expenditures with 0% coinsurance during the current insurance period. This division gives one bracket, 5a, in which consumers could be expected to be about as comparable to those in bracket 4, in terms of health and experience of pharmaceuticals, as those in bracket 4 are to consumers in brackets 2 and 3. In column two of Table 1 we restate the coinsurance rates and in columns three and four we restate the range of accumulated expenditures for consumers in each bracket whose insurance period started 2011 or earlier and 2012, respectively. Remember, that ranges for insurance periods starting 2013-2016 are nearly identical to those starting 2012. In columns five and six, we report for each bracket the percentage of the prescriptions and number of prescriptions, respectively, for which the first part of the expenditure falls in the bracket, e.g. a purchase with say a 5% coinsurance due half the cost falling in the 10% bracket and half in the 0% bracket is reported in the 10% bracket. Then, in column seven we ignore prescription with cost in several brackets and report for each bracket the number of prescriptions for which the cost covered by the benefit scheme falls entirely into the bracket.

Table 1. Distribution of prescriptions across coinsurance brackets

Bracket	Coins. rate	Interval of acc. exp. for insurance periods starting	Prescriptions with cost starting in bracket	Prescriptions with all cost within bracket

[4] Most of these are from the billing month October 2011, when there was an error done when creating the consumer identifier which affected all observations. Using information on year and month of birth, gender, municipality, preferred health center, and place in the benefit scheme, we have been able to identify to which consumer half of the observations from this month belongs to. Details on how this is done, and how consumers' positions in the benefit scheme are calculated, are available from the authors upon request.

		≤ 2011	2012	%	Frequency	Frequency
1	100%	0-900	0-1100	49.23	906,097	736,278
2	50%	900-1700	1100-2100	14.46	266,178	169,264
3	25%	1700-3300	2100-3900	12.98	238,912	173,588
4	10%	3300-4300	3900-5400	5.20	95,779	50,011
5a	0%	4300-6300	5400-7400	4.89	89,960	59,190
5b	0%	6300-8300	7400-9400	2.59	47,589	29,098
5c	0%	8300-	9400-	10.64	195,870	195,870
Sum				100	1,840,385	1,462,560

The dataset contains one variable indicating the additional cost paid by the consumer if they choose to buy another product instead of the cheapest one. This variable is zero for 95% of the prescriptions, i.e. in only 5% of the cases, consumers paid extra to avoid the cheapest alternative. This can be compared with a national figure stating that 3% opposed substitution October 2002 through December 2003 (National Corporation of Swedish Pharmacies et al. 2004).

66% of the prescriptions without additional cost were filled by the product (or one of the products in cases of ties) that had the lowest price per pill in the exchange group in the beginning of the current month. 5% were filled by the previous month's cheapest product. Some are filled by products that cost less than SEK 0.5 more than the cheapest one, so that the additional cost was rounded off to 0. Others were filled by product that became the cheapest available in Sweden when the first cheapest were sold out. We cannot identify this share in the data, but national data suggest that it might be 10-15%. Then, there likely remain some that are sold without additional cost, even though the rule stipulates otherwise. For example, it might be that some pharmacies that do not have the cheapest product in stock, break the rules by selling the cheapest one that they have in stock without any additional costs. In this paper, we for simplicity refer to the share of products sold without additional cost to the consumer as the market share of the cheapest product.

3.1 Descriptive statistics of market shares

In this subsection, we follow Shampanier et al. (2007) by studying if the shares of packages sold without additional cost to the consumers differ across coinsurance brackets. When doing this, we restrict our attention to observations where the cost covered by the benefit scheme

falls entirely into one bracket. If the zero-price effect exists, the share buying the cheapest product would be larger for consumers who could get the cheapest product for free.[5] The purpose of this subsection is to see if we observe some preliminary evidence of zero-price effect.

Table 2 first reports the weighted average percentage market share of the cheapest product for bracket 1, denoted MS1. Then, for brackets 2 to 5c, the weighted average difference in this percentage market share relative to preceding bracket and the standard error for this difference are reported. For the averages, the number of packages sold in each exchange group-month-bracket combination is used as weights and for the differences the sum of number of packages in the two relevant exchange group-month-bracket combinations is used.[6]

The numbers reported are for all exchange groups and month combination with positive sales in bracket 1 for row 1 and in the two relevant brackets for the other rows. Hence, the differences should not be caused by differences in choices of products or in price-differences across products, but could be caused by differences in consumer characteristics. In columns two and three we report figures just for male and female consumers, respectively, and in columns four, five and six we report figures separately for the age groups 18-59, 60-71, and 72 or older.

Table 2. Difference of means of market shares between coinsurance brackets

	1. All	2. Men	3. Women	4. 18-59	5. 60-71	6. 72-104
MS1	95.14	95.99	94.23	96.11	95.01	93.82
MS2-MS1	-0.18***	-0.09	-0.18*	0.18	-0.08	-0.24**
	(0.07)	(0.09)	(0.10)	(0.11)	(0.12)	(0.11)
MS3-MS2	0.15	0.19	0.21	0.32*	0.38**	0.13
	(0.09)	(0.13)	(0.13)	(0.16)	(0.16)	(0.14)
MS4-MS3	-0.07	-0.09	-0.15	-0.15	-0.30	0.06
	(0.13)	(0.18)	(0.18)	(0.24)	(0.23)	(0.19)
MS5a-MS4	0.93***	0.86***	1.03***	0.54*	1.37***	1.00***

[5] Some consumers in the brackets with positive coinsurance rates might be certain that they will reach the 0% coinsurance bracket within the 12-month insurance period, irrespective of whether they fill the current prescription. That is, they might be certain that they will pay the maximum amount within the benefit scheme irrespective of whether they fill the current prescription. For these consumers, the actual incremental cost of buying the cheapest product is just the difference in present value between paying the coinsurance for this drug now and paying the same amount later. Still, this incremental cost should be positive given that the discount rate is positive.

[6] The differences across brackets are similar if no weight is used or if the weight used is equal across brackets within the same exchange group-month combination, but the standard error is larger without weights.

	(0.15)	(0.22)	(0.21)	(0.29)	(0.29)	(0.25)
MS5b-MS5a	0.28*	0.64***	0.08	0.49*	0.32	0.14
	(0.17)	(0.22)	(0.24)	(0.29)	(0.30)	(0.25)
MS5c-MS5b	0.90***	0.42	1.31***	0.40**	0.73***	0.69
	(0.16)	(0.20)	(0.24)	(0.26)	(0.27)	(0.24)
#Prescr	1,462,560	700,418	762,142	496,973	471,138	494,449

Note: MSX, where X=1,2,…5c , is the weighted average percentage market share of the cheapest product within bracket X. Hence, e.g. MS2-MS1 is this market share within bracket 2 minus this market share in bracket 1. Standard errors are given in parenthesis. ***, **, * indicate that the coefficient is statistically significant different from zero on the 1%, 5% and 10% significance levels, respectively.

Table 2 shows relatively small differences across the first four brackets. The market share of the cheapest product is in many samples lower in bracket 2 than in bracket 1, but is in bracket 3 back to a similar level as in bracket 1. For all samples we see an increase between bracket 4 and the 0% co-payment bracket (i.e. the bracket where consumers choosing the cheapest product pay nothing out of pocket). Interestingly, the increase between bracket 4 and the first part of the 0% bracket, i.e. bracket 5a, is statistically significant and around one percentage point for all samples, except for the youngest consumers (column 4). This is consistent with a zero-price effect. However, it could also be driven by other factors correlating with consumers' accumulated expenditure and hence with their insurance bracket. This correlation could be caused by accumulated expenditure being correlated with factors like age, health and consumption history, which in turn affect the preference for different products. We also see that the market share of the cheapest product continue to increase as consumers' accumulated expenditures continue to increase in bracket 5. In the light of this, one might suspect that the significant difference between brackets 4 and 5a is caused by a positive correlation between consumers' accumulated expenditure and the market share of the cheapest product within the 10% and 0% coinsurance brackets, and not by a zero-price effect. We study this possibility closer in the next section by means of a regression discontinuity design.

4. Regression Discontinuity

Here we employ a (sharp) regression discontinuity (RD) design (see, e.g., Imbens and Lemieux, 2008) to study the zero-price effect. We use the accumulated total expenditures as the forcing variable because it determines which coinsurance bracket the consumer belongs to. Between the years 2011 and 2012 and 2012 and 2013 the benefit scheme changed slightly

as was described in Section 2. Consumers with insurance period starting before 2012 entered into the 0% coinsurance bracket when her accumulated expenditure on prescribed pharmaceuticals exceeded SEK 4,300 (approx. USD 500) and for insurance period starting 2012 and 2013 this cut-off amount was set to SEK 5,400 (approx. USD 630) and SEK 5398.8, respectively. Therefore, we have subtracted SEK 4,300, SEK 5,400, or SEK 5298.8 from the consumers' accumulated expenditure depending on whether the insurance period started in 2011 or earlier, in 2012, or in 2013; consequently, the cut-off point is at zero.

We have proceeded as follows: around the cut-off points at zero of the accumulated total cost variable, we have defined intervals of width SEK 50 (approx. USD 6), and calculated the mean accumulated total cost using all observations within each interval. Using all the observations belonging to such an interval for each exchange group and month, we have calculated the share of lowest-priced drugs consumed to all drugs consumed. We use the same sample as in subsection 3.1. We have constructed a total of 80 intervals, within the set where the total cost is between -2,000 and +2,000 SEK from the cut-off point at zero. After doing this, 310,413 observations remain generated by 42,554 individuals. Summary statistics are displayed in Table 3.

Table 3. Regression discontinuity summary statistics

No. of intervals	80
Average share of lowest-priced drugs transacted	0.9495
Average number of observations within each interval	4,128.35

We try out different polynomial forms in our RD specification and employ local polynomial regression for estimation. Table 4 presents the parameter estimates obtained when weighting the observations by the proportion of observations used to calculate that particular data point. As can be seen, the zero-price effect is insignificant across all specifications. Hence, the results here cannot reject the null hypothesis of a no zero-price effect. Here it is worth noting that the standard errors are small, indicating that the probability of a type 2 error is relatively smaller here than in e.g., the study by Baumbach (2016) discussed in the introduction.

Further, RD plots for the cases employing local polynomials of order two and three, respectively, are given in Figures 1 and 2. The plots confirm the findings given in Table 4. The plots also illustrate that the difference between the 10% and 0% coinsurance brackets, observed in the descriptive statistics in Table 2, is caused by a positive correlation between consumers' accumulated expenditure and the market share of the cheapest product within these brackets.

Table 4. Regression discontinuity parameter estimates.

Effect using a polynomial of order 1	-0.0042
	(0.0022)
Effect using a polynomial of order 2	-0.0048
	(0.0025)
Effect using a polynomial of order 3	-0.0049
	(0.0028)
Effect using a polynomial of order 4	-0.0048
	(0.0030)

Standard errors are given in parentheses.

Figure 1. Regression discontinuity plot, employing local polynomials of order 2.

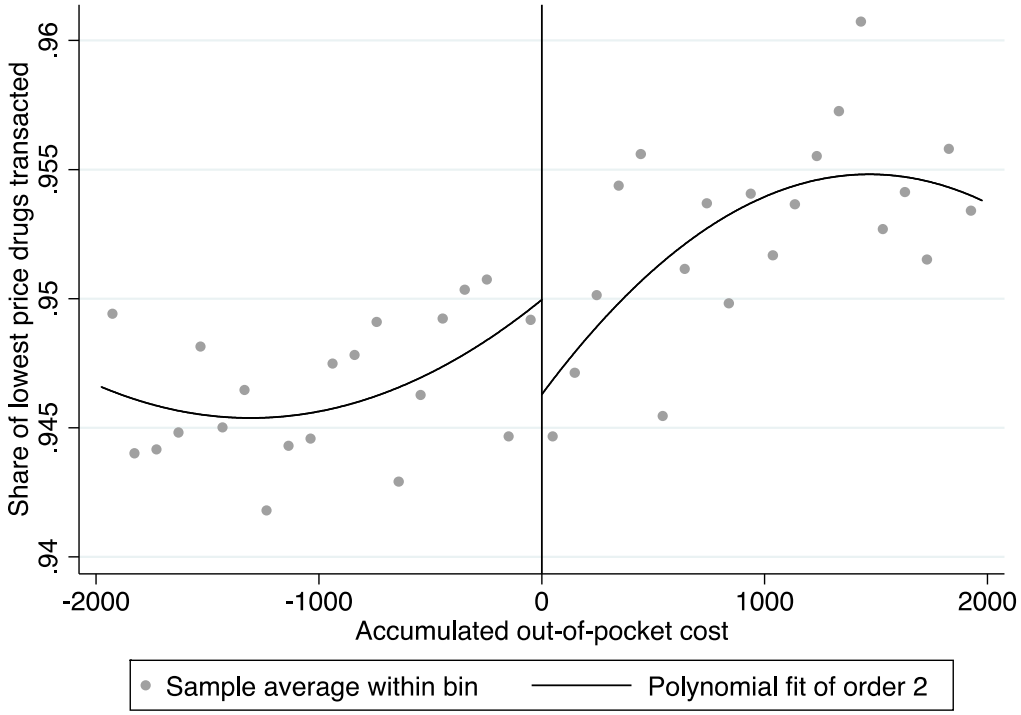
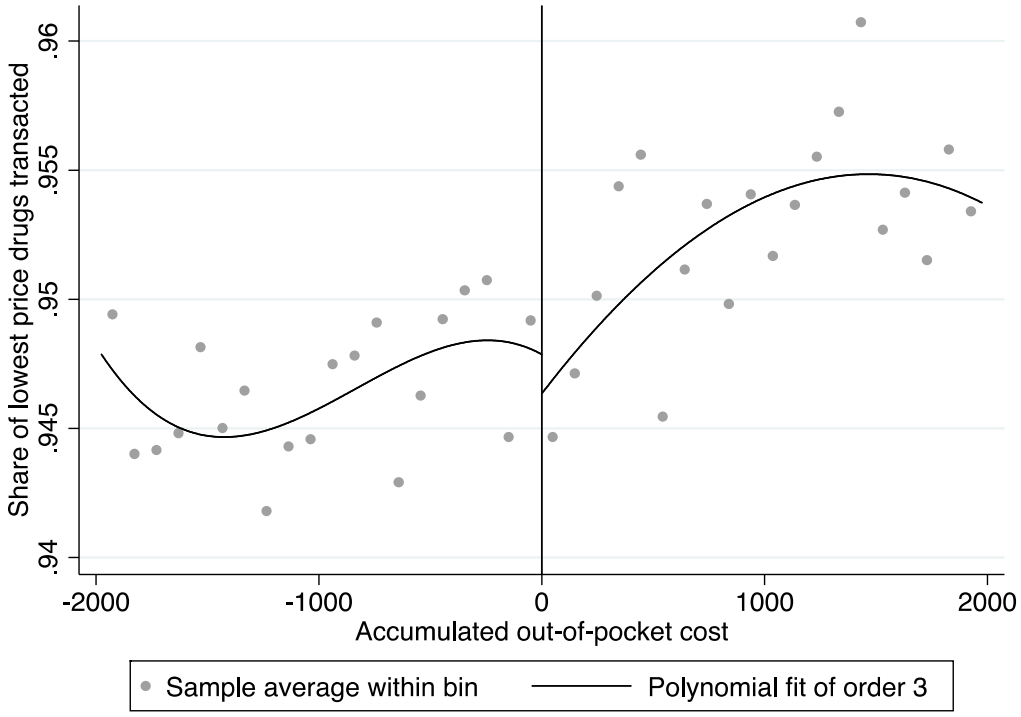


Figure 2. Regression discontinuity plot, employing local polynomials of order 3.



5. Choice modelling

Now we turn to study the consumers' choices in more detail by using random utility specifications. As the whole sample contains too many choices (i.e., drugs) to make estimation feasible, we estimate here for three selected exchange groups. We have chosen to look on the statin Simvastatin, a synthetic form of vitamin B12, Cyanocobalamin, which is used to treat, e.g., pernicious anemia and other types of hematological and neurological diseases and also the beta blocker Metoprolol. For each of these drugs, we choose the exchange group with the largest amount of observations. For all drugs, these are exchange groups with the package size of about 100 pills. The exchange group for Simvastatin is for 20 milligram tablets and contains 13 generic drugs.[7] For Cyanocobalamin, the exchange group is for 1 milligram tablets and contains the drugs Behepan, Betolvex and Betolvidon. For the beta blocker, the exchange group is for 50 milligram tablets and contains six drugs.[8] Our consumer

[7] These are Simvastatin ratiopharm, Simvastatin STADA, Simvastatin Actavis, Simvastatin Krka, Simvastatin Pensa, Simvastatin Arrow, Simvastatin Orion, Simvastatin Ranbaxy, Simvastatin Orifarm, Simvastatin Sandoz, Simvastatin Teva, Simvastatin Bluefish and Simidon.

[8] These are Metoprolol Radiopharm, Metoprolol Sandoz, Metoprolol Orion, Metoprolol Actavis, SelokenZOC (98 pills) and SelokenZOC (100 pills).

characteristics consist of the consumer's age at the time of purchase, the consumers gender and also the consumer's accumulated expenses on drugs over the past 12 months. Descriptive statistics are found in Tables 5 and 6.

For each of the three exchange groups, we estimate the parameters of the following (indirect) utility function:

$$U_{ijt} = \alpha_{ij} + p_{ijt}\left(\beta_p + Z_{it}\beta_1\right) + GL\left(H_{ijm}, \delta\right)(\gamma_{GL} + Z_{it}\gamma_1) + LP_{jt}(\theta_{LP} + Z_{it}\theta_1) + ZP_{ijt}(\kappa_{ZP} + Z_{it}\kappa_1) + e_{ijt}.$$

Here the α_{ij} denote drug-specific intercepts for goods $j = 1, \dots, J$ that capture consumer i's tastes for the unobserved attributes of drug j. One of the α_{ij} is set to a constant (zero) for identification reasons. p_{ijt} is the price facing consumer i of good j at time t, and $i = 1, \dots, I$ and $t = 1, \dots, T$. Note that the drug-specific prices are also consumer-specific as they potentially differ across consumers at a given time with respect to where the consumer is situated in the benefit scheme. The coefficient on price is $\beta_p + Z_{it}\beta_1$, where Z_{it} is a vector of observed consumer characteristics containing information on the consumer's gender, age and accumulated total cost at time t of prescription drugs from the start of the current 12-month period. We do not observe the prices of each good each month. Missing prices occur if the product is not sold that month to any consumer in the data. This might be caused by an unusually high price or by the product not being available at the pharmacies that month and we therefore impute the missing prices by the maximum price observed for that good over the whole sample period. Using mean values instead is found to give similar results.

The term $GL\left(H_{ijm}, \delta\right)$ is a state dependence variable commonly used in marketing studies (see, e.g., Ching et al., 2009 and Guadagni and Little, 1983). In GL, H_{ijm} is consumer i's purchase history for brand j prior to month m, δ is the exponential smoothing parameter; explicitly we write $GL_{ijm} = \delta GL_{ij,m-1} + (1-\delta)d_{ij,m-1}$; $d_{ij,m-1}$ is an indicator that equals one if the consumer bought brand j in month $m-1$, and zero otherwise. The coefficient on the GL term depends on Z_{it}, i.e., age, gender and the accumulated costs of the consumer.

The variable LP_{jt} is an indicator variable that equals one if drug j was the lowest priced product at time t (i.e., a drug for which the consumer did not have to pay an excess fee) and zero otherwise. As in the case for price, the coefficient on LP_{jt} is allowed to depend on the consumer's gender, age and accumulated cost of prescription drugs as described above.

ZP_{ijt} is an indicator variable indicating whether the price of good j facing consumer i was zero at time t. We let the zero-price effect depend on Z_{it}, i.e., age, gender as well as the accumulated costs of the consumer. The Greek letters are parameters to be estimated.

We assume $\boldsymbol{\alpha_i}$ to be multivariate normally distributed to capture potential correlation of the consumers' tastes between drugs. The e_{ijt} is an i.i.d. extreme value term capturing the idiosyncratic taste of consumer i for drug j at time t.

Note that we face an initial conditions problem as we do not observe the consumers' choices before $m = 1$ (Heckman, 1981). This creates a problem in creating the initial value of the GL variable, $GL(H_{ij1}, \delta)$. Further, even if we observed $GL(H_{ij1}, \delta)$, it would be correlated with the brand intercepts α_{ij}. To alleviate these problems, we hold out n months of individual choice histories from the estimation sample and use these to impute the initial value $GL(H_{ij1}, \delta)$.[9] When we have imputed values on $GL(H_{ij1}, \delta)$, we integrate over the joint distribution of $GL(H_{ij1}, \delta)$ and α_i using the procedure propsed by Wooldridge (2005). Here the distributions of the α_{ij}, i.e., the unobserved heterogeneity terms, are allowed to be functions of the imputed initial values $GL(H_{ij1}, \delta)$ as

$$\alpha_{ij} = \alpha_j + GL(H_{ij1}, \delta)\alpha_{GL} + \varepsilon_{ij}$$

where ε_{ij} is multivariate normally distributed with mean equal to zero.

There is no closed form for the choice probabilities, as, e.g., $\boldsymbol{\alpha_i}$ is a J-dimensional multivariate normal vector. Consequently, we use simulated maximum likelihood to estimate the parameters of this heterogeneous multinomial logit model (MNL) (see, e.g., Harris and Keane, 1998; Ching et al., 2009). For each $\boldsymbol{\alpha_i}$ we use 200 draws to simulate the integrals by Monte Carlo methods (see, e.g., McFadden, 1989).

The primary parameters of interest here are κ_{ZP} and κ_1 which capture the zero-price effect on the consumers' utility. The parameter estimates for each exchange group are presented in Table 7. To save space, the intercepts are not presented here, but are available from the authors upon request. We give the variances and correlations of the intercepts in the Appendix.

[9] We set $n = 4$; at $m = 1 - n$ we assume that $GL(H_{ij1-n}, \delta) = 0$.

Table 5. Summary statistics of the data and consumer characteristics

	Simvastatin	Cyanocobalamin	Metoprolol
No. of consumers	14,113	10,661	11,120
No. of choices	13	3	6
Max no. of months observed per consumer	18	23	27
Average no. of months observed per consumer	8.831	8.945	9.207
Fraction women over purchases	0.453	0.566	0.481
Average age of consumer over purchases	68.207	72.219	68.546
Age $25^{th}/50^{th}/75^{th}$ percentile	61/69/76	65/75/83	61/69/78
Average accumulated total cost	2,160.031	3,922.683	2,594.069
Average accumulated total cost $25^{th}/50^{th}/75^{th}$ percentile	129.50/994.50/ 2342.96	527/1696/4041. 3	277/1102/261 9.16

Table 6. Summary statistics of product characteristics

	No. of observations	Share (%)	Mean prices (p_{ijt})
<u>Simvastatin</u>			
1. Simvastatin Ratiopharm	13	0.01	0.89
2. Simvastatin STADA	525	0.5	0.51
3. Simvastatin Actavis	5,635	6	1.09
4. Simvastatin Krka	3,702	4	0.52
5. Simvastatin Pensa	5,758	6	1.04
6. Simvastatin Arrow	945	1	0.63
7. Simvastatin Orion	2,868	3	1.14
8. Simvastatin Ranbaxy	16,006	18	0.35
9. Simvastatin Orifarm	3,231	4	0.91
10. Simvastatin Sandoz	11,770	13	0.52
11. Simvastatin Teva	14,649	16	0.48
12. Simvastatin Bluefish	12,332	13	0.38
13. Simidon	13,937	15	0.64

Cyanocobalamin			
1. Behepan	14,773	22	0.46
2. Betolvex	41,868	63	0.42
3. Betolvidon	9,819	15	0.44
Metoprolol			
1. Metoprolol Radiopharm	7,454	11	0.74
2. Metoprolol Sandoz	42,485	61	0.48
3. Metoprolol Orion	7,452	11	0.91
4. Metoprolol Actavis	3,239	5	1.27
5. SelokenZOC (98 pills)	4,143	6	1.33
6. SelokenZOC (100 pills)	5,319	8	1.32

Table 7. Parameter estimates

	Simvastatin	Cyanocobalamin	Metoprolol
β_p	-2.8943	1.8256	-1.975
	(1.0234)	(1.0059)	(0.9876)
β_{gend}	0.0079	-0.1316	-0.4103
	(0.0155)	(0.8220)	(0.2259)
β_{age}	-0.0001	0.0129	0.0231
	(0.0007)	(0.0149)	(0.0137)
β_{acc}	-0.00004	-0.0001	0.00001
	(0.00007)	(0.0001)	(0.00003)
γ_{GL}	1.8217	5.8537	6.5119
	(1.0529)	(1.1362)	(2.3311)
γ_{gend}	0.2016	-0.1658	0.4973
	(0.0278)	(0.9984)	(0.9826)
γ_{age}	0.00001	0.0040	0.0831
	(0.00007)	(0.0163)	(0.0331)
γ_{acc}	-0.00004	0.0003	-0.0001
	(0.00026)	(0.0001)	(0.0001)
δ	0.8521	0.9032	0.9082
	(0.0142)	(0.0043)	(0.0050)
θ_{LP}	20.0419	10.0360	19.2488
	(0.9998)	(1.0010)	(1.0050)
θ_{gend}	0.4164	0.3342	-0.0656
	(0.3822)	(0.9995)	(1.0119)
θ_{age}	0.0080	0.0775	-0.0165
	(1.0012)	(0.0292)	(0.0353)
θ_{acc}	-0.0001	0.0002	0.0003
	(0.0005)	(0.0006)	(0.0007)
κ_{ZP}	-0.6331	-0.1279	-1.4979
	(0.9999)	(0.9999)	(0.9999)
κ_{gend}	0.0722	0.0018	0.0121
	(1.0000)	(0.9999)	(1.0003)
κ_{age}	-0.0078	0.2546	-0.0188
	(1.0016)	(1.0000)	(0.0413)
κ_{acc}	0.0004	0.0001	-0.0001
	(0.0090)	(0.0006)	(0.0008)
α_{GL}	1.7328	3.5303	6.3218
	(0.9966)	(0.9752)	(1.0249)
Observations	91,371	66,420	70,092
No. of drugs	13	3	6
Log likelihood	-1310.172	-667.590	-2503.591
AIC	2836.343	1381.180	5083.183
BIC	3853.993	1590.567	5431.171

Standard errors are given in parentheses.
For statins, Simidon is the reference drug. For Cyanocobalamin, Betolvidon is the reference drug. For beta blockers, the reference drug is SelokenZOC (100 pills).

We observe that the zero-price effect (i.e., the estimates on κ_{ZP}, κ_{gend}, κ_{age} and κ_{acc}) is insignificant in a statistical sense across all three exchange groups. Also, $\kappa_{ZP} + Z_{it}\kappa_1$ is found to be insignificant in a statistical sense for all consumers facing a price of zero. Hence, we cannot find evidence for a zero-price effect here. For the statins Simvastatin and the beta blockers (Metoprolol), the estimates of the price coefficient are negative at the mean levels of the Z-variables (gender, age and accumulated expenditures), and statistically significant i.e., consumers obtain disutility from higher prices. For the synthetic vitamins (Cyanocobalamin), the estimate of the price coefficient at the mean levels of the Z-variables is not statistically different from zero. For all exchange groups, the parameter estimates of the lowest priced drug is positive and statistically significant; so, in addition to the negative (or no) effect of price on utility, consumers obtain additional utility by choosing a drug without excess fee. The estimate of the parameter associated with the GL term is positive and statistically different form zero for Cyanocobalamin and Metoprolol, implying that consumers obtain positive utilities by repeatedly consuming the same drug. For Simvastatin, the parameter estimate on the GL term is not different from zero in a statistical sense.

Some further interesting findings here are that, for Simvastatin, women seem to obtain a larger amount of utility from repeatedly consuming the same brand. Moreover, we observe that the parameter estimates on α_{GL} is quite large and statistically significant for Cyanocobalamin and Simvastatin, i.e., the consumers' pre-sample behavior yields information about brand preferences.

To summarize this section: after controlling for drug-specific characteristics, price, purchase history and the cheapest good of the month, we find no evidence for that a zero give additional utility to the consumer.

6. Conclusion

The results of Shampanier et al. (2007) indicate that affect, i.e. that options with no downside can invoke a positive affective response, is the main cause of the zero-price effect they found. When they made respondents answer questions on how much they liked the cheaper chocolate compared to the more expensive and how much more they would hate having to pay the higher price compared to the lower price, before making a hypothetical choice between which one to buy, the zero-price effect became statistically insignificant.

It is possible that the reason that we find no zero-price effect is because affect plays a minor role in the choices between prescription drugs that we study. First, consumers in the zero-coinsurance bracket might not feel much positive affect by being offered to buy the cheapest product for free. Instead, they may feel that they have earned this offer by having paid out of pocket in the previous brackets before reaching the zero percent bracket, and by helping to finance the benefit scheme through taxes. They may also think that the free product can involve downsides in terms of medical side effects. Second, as Hossain and Saini (2015) suggest, consumers may let any positive affect they might experience play a smaller role in the choice among utilitarian goods (e.g. pharmaceuticals) as compared to choices among hedonic goods (e.g. chocolate). A contributing explanation to our results could be that all, except those with very strong brand preferences, irrespective of coinsurance bracket, buy the cheapest drug since pharmacy personnel inform them that the exchangeable products are medically equivalent and offer them to substitute to the cheapest alternative to avoid additional costs. Those with very strong brand preferences might in turn not be very easily influenced by affect.

Our results indicate that differences in co-payments affect consumer choices, and that consumers are especially likely to choose the cheapest drug. Therefore, insurance providers that want to increase the share of prescriptions filled by generics, should charge lower co-payment for generics than for brand name drugs. However, our results indicate that an equal reduction in co-payments for all drugs, that reduce the co-payment for generics to zero, will not further increase the likelihood that specific consumers choose generics. An interesting topic for future research though is if a zero coinsurance for generics can affect the composition of insurees, by making the insurance especially attractive for consumers inclined to buy generics. To inform insurance providers and marketers and to increase the general knowledge about consumer behaviors, more research regarding the zero-price effect, using field data or experiments, is needed both for utilitarian and hedonic goods.

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Appendix

Correlations and variance of alphas, statins

```
corr[2][1] = 0.961977
corr[3][1] = -0.672461
corr[3][2] = -0.617137
corr[4][1] = 0.798540
corr[4][2] = 0.911089
corr[4][3] = -0.262862
corr[5][1] = -0.328523
corr[5][2] = -0.201596
corr[5][3] = 0.206447
corr[5][4] = -0.055084
corr[6][1] = 0.254034
corr[6][2] = 0.431607
corr[6][3] = 0.049918
corr[6][4] = 0.622590
corr[6][5] = 0.631135
corr[7][1] = 0.051247
corr[7][2] = 0.113847
corr[7][3] = -0.035256
corr[7][4] = 0.153005
corr[7][5] = 0.414251
corr[7][6] = 0.430519
corr[8][1] = 0.388651
corr[8][2] = 0.386871
corr[8][3] = -0.099787
corr[8][4] = 0.408286
corr[8][5] = -0.032638
corr[8][6] = 0.218744
corr[8][7] = 0.213688
corr[9][1] = 0.370003
corr[9][2] = 0.497762
corr[9][3] = -0.070867
corr[9][4] = 0.626218
corr[9][5] = 0.018871
corr[9][6] = 0.185703
corr[9][7] = -0.240746
corr[9][8] = 0.066980
corr[10][1] = 0.086913
corr[10][2] = 0.159497
corr[10][3] = -0.014784
corr[10][4] = 0.217600
corr[10][5] = 0.532032
corr[10][6] = 0.605068
corr[10][7] = 0.539388
corr[10][8] = -0.306628
corr[10][9] = -0.083288
corr[11][1] = -0.123825
corr[11][2] = -0.040867
corr[11][3] = -0.180001
corr[11][4] = -0.068203
corr[11][5] = 0.324131
corr[11][6] = 0.264831
corr[11][7] = 0.317710
corr[11][8] = 0.137759
corr[11][9] = -0.240794
corr[11][10] = 0.460363
corr[12][1] = 0.488615
corr[12][2] = 0.635533
corr[12][3] = -0.240194
corr[12][4] = 0.714640
corr[12][5] = -0.037512
corr[12][6] = 0.485345
corr[12][7] = 0.094372
corr[12][8] = 0.128599
corr[12][9] = 0.499833
corr[12][10] = 0.239722
corr[12][11] = 0.046970

variance of alpha_1 = 1.067383.
variance of alpha_2 = 22.463921.
variance of alpha_3 = 0.886701.
variance of alpha_4 = 8.831790.
variance of alpha_5 = 32.688382.
variance of alpha_6 = 7.235888.
variance of alpha_7 = 10.812215.
variance of alpha_8 = 26.824505.
variance of alpha_9 = 9.970472.
variance of alpha_10 = 20.069675.
variance of alpha_11 = 32.907504.
variance of alpha_12 = 11.048942.
```

Correlations and variances of alphas, Cyanocobalamin

```
corr[2][1] = 0.999796

variance of alpha_1 = 1.287763.
variance of alpha_2 = 0.021560.
```

Correlations and variances of alphas, beta blockers

```
corr[2][1] = -0.981012
corr[3][1] = 0.375408
corr[3][2] = -0.271720
corr[4][1] = -0.832740
corr[4][2] = 0.723574
corr[4][3] = -0.426529
corr[5][1] = -0.641281
corr[5][2] = 0.604557
corr[5][3] = 0.105750
corr[5][4] = 0.678145

variance of alpha_1 = 0.017988.
variance of alpha_2 = 3.412350.
variance of alpha_3 = 0.132562.
variance of alpha_4 = 5.336248.
variance of alpha_5 = 2.601723.
```