WORKING PAPER 10-01

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ISBN 9788778824257 (print)

ISBN 9788778824264 (online)

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January 15, 2010

Abstract:

This paper investigates price sensitivity of demand for prescription drugs using drug purchase records for at 20% random sample of the Danish population. We identify price responsiveness by exploiting exogenous variation in prices caused by kinked reimbursement schemes and implement a regression kink design. Thus, within a unifying framework we uncover price sensitivity for different subpopulations and types of drugs. The results suggest low average price responsiveness with corresponding price elasticities ranging from -0.08 to -0.25, implying that demand is inelastic. Individuals with lower education and income are, however, more responsive to the price. Also, essential drugs that prevent deterioration in health and prolong life have lower associated average price sensitivity.

Key words: Prescription drugs, price, reimbursement schemes, regression kink design
JEL codes: I11, I18

Acknowledgements: We greatly appreciate valuable comments from Søren Leth-Petersen, Emilia Simeonova, Michael Svarer, and Torben Sørensen. The paper has benefited from comments received at the 2007 iHEA conference, the 1st meeting of the Danish Microeconometric Network 2009 and at seminars at the Stockholm School of Economics, the Swedish Institute for Social Research, University of Stockholm and at IZA, Bonn. The usual disclaimer applies.

1. Introduction

During 1998-2007, real pharmaceutical spending within the OECD went up almost 50%, reaching more than USD 650 billion in 2007. Furthermore, drug spending (prescription and non-prescription) amounted to an impressive 15% of total health spending with a US growth that was more than twice of that of total health expenditures; see OECD (2009). Spending on pharmaceuticals is foreseen to increase even further in the future, putting severe pressure on health care budgets. To control such spending, there is increased interest in designing optimal health insurance schemes. Necessary inputs into the construction of health insurance policies are reliable estimates of price sensitivity of demand yet the empirical evidence in this area is limited and the existing estimates vary considerably. Furthermore, different subgroups in the population do not invest the same in their own health and do not face the same budget constraints. To the extent that subgroups will also react differently to prices of prescription drugs, subgroup specific estimates are crucial.

Clearly, the task of uncovering price sensitivity of demand for drugs is complicated by the standard selection problem: individuals who purchase prescription drugs do not constitute a random part of the population; presumably they have a higher willingness to pay than individuals who refrain from buying. Moreover, even if studies attempt to deal with this essential identification problem, they are often not able to distinguish spending on one type of prescription drug from other types or even from different types of health care usage such as hospital admittance. In other cases, the type of drug is known but the price is not. This is typically solved by a combination of substantial assumptions and an imputation strategy. Finally, identification strategies often restrict the results to hold only for a specific subgroup of the overall population.

The perhaps most widely known study within this field is the RAND Health Insurance Experiment (HIE), which ran from the late 1970's to the start of the 1980's. The unique feature of the HIE was that insurance plans for non-aged individuals (61 or below) were randomly assigned in 6 different locations across the US. The insurance plans differed in the size of the deductible amount, co-insurance rates and full stop-loss; an annual limit on out-of-pocket expenditures. In this sense, the study had the flavor of a randomized experiment, which has led many to consider it the gold standard in the literature. The average price elasticity of overall health care demand including

prescription drugs, hospital utilization and other health care services was estimated to be -0.20 in the study, see Manning et al. (1987) and Newhouse (1993).

While well executed and evaluated, an important limitation of the RAND HIE was that it did not consider the elderly population that accounts for a large share of medical expenditures. Recognizing this point, Contoyannis et al. (2005) estimate the price elasticity for prescription drugs in the presence of a nonlinear price schedule for the elderly people (age 65 or over) enrolled in the Quebec Public Pharmacare program in Canada exploiting time variation in cost-sharing. Their overall finding is a price elasticity ranging from -0.12 to -0.16. Similarly, Chandra et al. (forthcoming) study price responsiveness for people enrolled in California Public Employees Retirement System (CalPERS) with focus on the elderly population. In 2001 co-payments went up for the fraction of enrollees under Preferred Provider Organizations (PPO), and in 2002 co-payments were increased for the fraction that received care through HMO's. Applying a difference-in-difference framework, the authors estimate drug utilization elasticities with respect to patient cost. Resulting elasticities range from -0.20 to -1.4.

Acknowledging the fact that price elasticities for prescription drugs are likely to be just at heterogenous across types of drugs as price elasticities for other types of products, Goldman et al (2004) and Landsman et al. (2005) study price responsiveness for different types of therapeutic groups. Using regression type analyses on pharmacy claims data combined with cross-sectional variation in health plan benefits designs, both studies find that drugs used for chronic conditions are less price sensitive (-0.1 to -0.2) than drugs used for more acute conditions (-0.3 to -0.6). Furthermore, Tamblyn et al. (2001) considers both the elderly population and welfare participants in Quebec, Canada and find that demand for essential drugs reacts less to the introduction of prescription drug cost-sharing than demand for less essential drugs.

In this paper we add to the scarce but growing literature and investigate the issue of whether demand for prescription drugs is sensitive to the price. We estimate the change in the propensity to consume caused by a change in the price. All estimates of price sensitivity are uncovered within a context where individuals may be forward looking and within a market where private health insurance – that may cover part of or all costs related to prescription drugs – exists. We believe that these are the policy relevant parameters if one is interested in changing the current system

marginally.[1] We use a rich register-based data set on a 20 % random sample of the Danish population in the period 2000-2003. Contrary to many existing data sets, ours includes information on therapeutic group, price, and out-of-pocket payment for every prescription drug purchase. These data are augmented with socio-economic characteristics on a yearly basis. Besides superior data, our main contributions are the following: 1) we use a *regression kink* design to overcome the standard selection problem. The idea is very close to that of a regression discontinuity design (see for example Lee and Lemieux (2009)) except that instead of a shift in levels, we exploit a shift in slopes.[2] Here we directly exploit that coinsurance payments decrease in a discontinuous fashion as consumption (on a yearly basis) increases. In principle, there is no reason to think that individuals *just above* a given kink point are different from individuals *just below* – except for the fact that the price faced by individuals below the kink point decrease *less* with total consumption than for individuals above the kink point. Comparing the propensity to purchase for individuals who are just above and just below kink points then allows us to identify price sensitivities. While we are not the first to acknowledge the existence of this type of identification, see for example Guryan (2003) and Nielsen, Sørensen, and Taber (forthcoming), we are, to the best of our knowledge, among the very first to directly implement such a design. Recently, Card, Lee and Pei (2009) have established conditions under which the regression kink design nonparametrically identifies the "local average response" (Altonji and Matzkin (2005)) or, equivalently, the "treatment on the treated" (Florens, Heckman, Meghir and Vytlacil (2008)). Card, Lee and Pei (2009) also provide the only other direct implementation of a regression kink design that we are aware of. 2) Health insurance is universally supplied by the Danish government, allowing us to use a unifying identification strategy to consider estimates for the entire Danish population as well as estimates for subgroups defined by socio-economic characteristics. Using the same identification strategy for all subgroups makes it much easier to compare estimates across subgroups. This is a major advantage compared to the existing studies that either only have access to (or exploit) a relatively young (RAND HIE) or old (Contoyannis et al. (2005), Chandra et al. (forthcoming)) population or do not distinguish between subpopulations. We demonstrate that estimates for relevant subgroups are of reasonable size and relate to each other in a meaningful way, which clearly increases the credibility of the overall

[1] Of course, our estimates are uninformative about underlying price sensitivity in the absence of a private health insurance market.

[2] In particular the tax literature has devoted considerable attention to kinks (in budget sets); see Moffitt (1990) for an early overview. Recently, these kinks have also been used as the basis for identification, for example to investigate the responsiveness of labor supply to tax schemes; see Saez (2009) and Chetty et al. (2009). In fact, various non-linear pricing schedules are often exploited to generate instruments in the economics literature; for recent examples see Rothstein and Rouse (2007), Nielsen, Sørensen and Taber (2008), and Dynarski, Gruber and Li (2009).

identification strategy. 3) Finally, in addition to providing subpopulation specific estimates, we also distinguish between types of drugs, something which is rarely possible simply because of lack of data.

Our results suggest that demand is inelastic; we find low average price responsiveness with a corresponding price elasticity ranging from -0.08 to -0.25, thus comparable to the results from the RAND HIE for the overall population. Individuals with lower education and income are, however, more responsive to the price. The same is true for the elderly population, though our estimates are somewhat smaller than those of Chandra et al. (forthcoming) and more in line with those of Contoyannis et al. (2005). Finally, essential drugs that surely prevent deterioration of health and prolong life have, as expected, much lower associated average price sensitivity than the complementary set of drugs.

The remaining part of the paper is organised as follows: Section 2 presents details of the Danish market for outpatient prescription drugs and subsidy policies. Section 3 presents the conceptual framework including a stylised economic model of drug purchase and links the model to parameters of interest and identification strategy. Section 4 outlines the features of the available data. Section 5 gives the results from the empirical analysis and Section 6 concludes.

2. The Danish Market for Outpatient Prescription Drugs

The Danish market for outpatient prescription drugs is highly regulated to secure correct handling of as well as uniform prices on drugs across pharmacies. Pharmaceutical companies report pharmacy purchase prices to the Danish Medicines Agency, who then announces retail prices. These retail prices (along with a comprehensive list of information about the specific drugs including substitutable drugs[3]) are made publicly available and registered online five years back in time. Furthermore, changes in purchase prices must be reported by the pharmaceutical companies two weeks ahead of time. Pharmacies must sell the cheapest substitute to prescription drugs unless

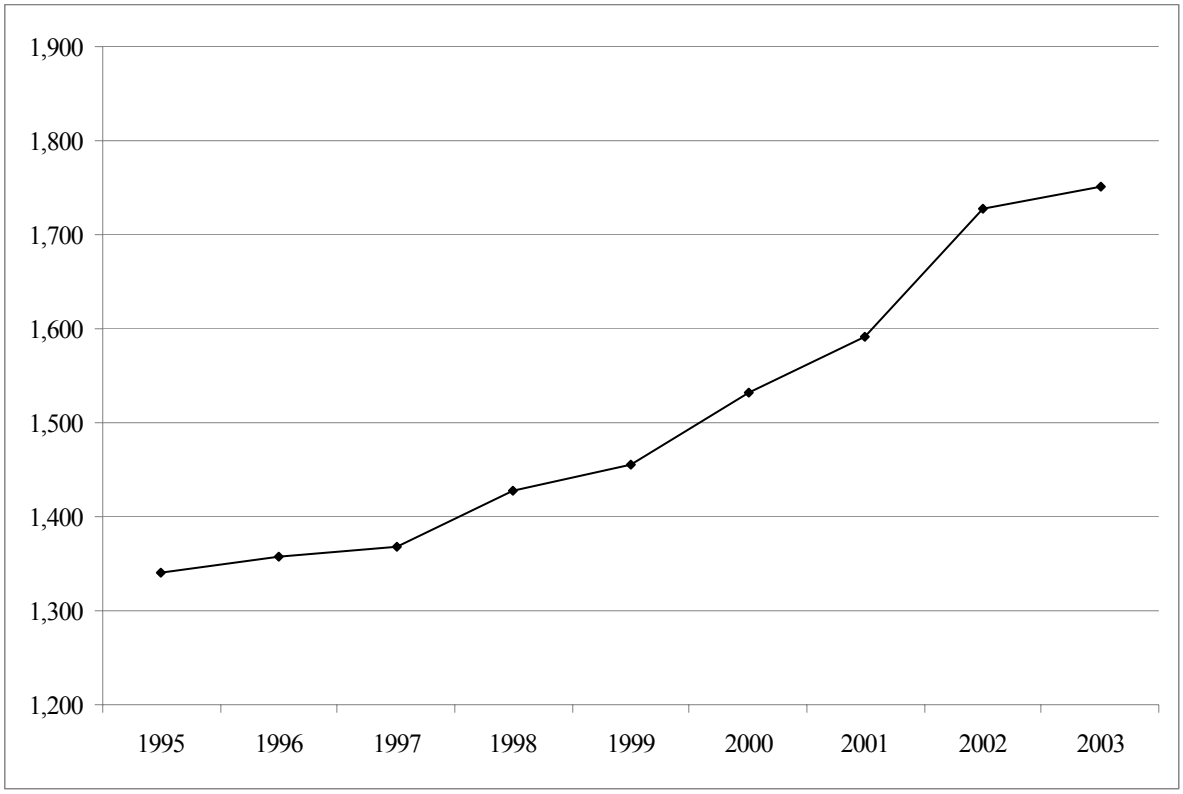
[3] Substitutes are defined by having the same dose of the active substance as well as the same use (tablets, capsules etc).

the prescribing doctor requires otherwise, or the patient specifically asks for another synonymous drug.[4] Doctors do not have monetary incentives to prescribe more or less expensive drugs.

Just as in the rest of OECD, consumption of prescription drugs has increased in a Danish context. Figure 1 shows average level of consumption in Danish Crowns (DKK)[5] in the period from 1995 – 2003 (in 1995 prices). On average, a Dane spent roughly DKK 1,750 on prescription drugs in 2003 while the median was around DKK 400. In comparison, the average patient in treatment for diabetes spent about DKK 4,400 on insulin and analogous products alone, the average patient in treatment for excess gastric acid production spent about DKK 1,300 on relevant products, while individuals in treatment with penicillin spent on average DKK 158.[6]

FIGURE 1

AVERAGE CONSUMPTION OF PRESCRIPTION DRUGS OVER TIME (DKK IN 1995)



[4] Before 1997, the physician was required to write on the prescription if substitution was allowed.
[5] € 100 corresponds to DKK 745 as of March 18 2009.
[6] Insulin and analogous products identified by ATC code A10A, treatments for excess gastric acid production ATC code A02A, penicillin ATC code J01C. See the Danish Medicines Agency for aggregate statistics, www.medicinpriser.dk and p. 20 for a description of the ATC system.

The subsidy scheme for adults 2000 - 2003

Subsidies were (and still are) based on the price of the products. Until June 25 2001, subsidies were based on the average price of the two cheapest substitutes. This was designated the *reference price*. After June 25 2001, this was replaced by a system where subsidies were based on the cheapest product among substitutes. This was called the *subsidy price*. However, if one or more of the substitutable products were sold within EU, the subsidy price would not be based on the Danish price but on the average price within EU.[7] Finally, products subject to parallel import received the same subsidy as the original product sold in Denmark.

Starting in March 2000, individual level purchases of subsidised products (see section below for a description) were entered into a central register, which all pharmacies draw their information from, and total costs were accumulated from the time of first purchase.[8] Accumulated total costs (from now on *TC*) are measured in reference/subsidy prices. Current *TC* is printed on receipts from drug purchases and thus always available to a potential customer. Furthermore, the Danish Medicines Agency provides a web page, www.medicinpriser.dk, where individuals can enter relevant information and check the price they face for a potential product *before* going to the pharmacy. A call to the pharmacy will yield the same information for those not connected to the internet.

TABLE 1

THE SUBSIDY SCHEME 2000 – 2003

	Mar.-Dec. 2000 DKK	2001 DKK	2002 DKK	2003 DKK
0 % of *TC*	0 - 500	0 - 510	0 - 515	0 - 540
50 % of *TC*	500 - 1,200	510 - 1,230	515 - 1,240	540 - 1,300
75 % of *TC*	1,200 - 2,800	1,230 - 2,875	1,240 - 2,900	1,300 - 3,040
85 % of *TC*	2,800 +	2,875 +	2,900 +	3,040 +

Table 1 describes the subsidy scheme. If an individual has a *TC* below a given threshold prior to purchasing and the price of buying a product brings *TC* above the threshold, the consumer will

[7] Prices in Greece, Spain, Portugal, and Luxemburg were excluded because income levels in these countries differed substantially from that of Denmark.

[8] Before March 2000, co-insurance rates were fixed at either 50 or 75 % depending on the type of product. An exception was Insulin to treat diabetes, which was free of costs. See Skipper (2009) for an analysis of the introduction of the new subsidy scheme.

receive the lower subsidy for the part of the price below the threshold and the higher subsidy for the part of the price above the threshold. To give an example, consider an individual who considers buying a product worth DKK 100. Assume that she has a *TC* of DKK 400 prior to the purchasing decision. In this case, she is not subject to any subsidy should she decide to buy and she will face the full price of DKK 100. Assume then instead that her *TC* prior to purchasing is DKK 450. Now she will receive no subsidy for DKK 50 and a 50 % subsidy for the DKK 50 that brings her *TC* account above the threshold point. In this alternative scenario, the price faced by the individual is DKK 75.

A year after the first purchase of prescription drugs, *TC* is re-zeroed. The structure of the subsidies forms the basis for identifying the effect of prices on demand for prescription drugs as described in the following section.

Retail prices of most prescription drugs are subsidised by the government, leading to a **general subsidy**, though some are only subsidised if the individual has a specific diagnosis or is officially retired. This is called a **conditional subsidy**.

Apart from general and conditional subsidies, an individual can receive **one-product**, **increased**, **chronic's**, **terminal**, and **municipality specific** subsidies. In our data, we can identify the type of subsidy individuals receive. One-product subsidies concern a specific type of product (and all its substitutes) that is subject to neither a general nor a conditional subsidy. A general practitioner makes the application on behalf of the patient and the Danish Medicines Agency is decisive. If the subsidy is granted, all purchases of the given product will be added to *TC* in the same manner as purchases of products with general or conditional subsidies. Typically, the subsidy will be granted for life but may in certain cases be shorter (for example if the product is not to be consumed over an extended period).

As pointed out above, general and conditional subsidies are based on the subsidy price. In very rare cases, individuals are granted an increased subsidy based on a more expensive product. This only occurs if the patient is allergic to a cheaper alternative or suffers from serious side-effects. The application procedure is the same as for one-product subsidies and, if granted, purchases are added to *TC*. Again, the subsidy is typically granted for life.

Chronically ill individuals with a predicted yearly *TC* above a certain threshold (around DKK 18,000 in the 2000-2003 period) may receive full compensation for any purchases above this value. The application procedure is the same as above but subsidies are only for a five-year period. In 2001 and 2002, 9,084 and 8,141 people out of a population of about 5.5 million people received chronic's subsidies. Terminally ill patients, who choose to spend the remains of their life at home instead of being hospitalised do not pay for any drug purchases (inpatient prescription drug consumption is free of charge as well). In 2001, 8,430 people received terminal subsidies, and in 2002 the number was 8,568. Finally, municipalities may choose to provide further subsidies. These are typically granted to low-wealth, low-income retirees.

As in most countries, there exists a private health insurance market as well. The most important player in the market for prescription drugs is the company, "Danmark". "Danmark" insures about 2 million Danes. Crucial for our study is that none of the policies of "Danmark" change at the kink points described above. In fact, none of "Danmark's" policies change with yearly consumption of prescription drugs. Furthermore, it is not possible to enroll if one has purchased any prescription drugs during the last 12 months.[9] The company offers four types of policies; Group 1, 2, 5, and Basis. Group 1 and 2 insurance (about 400,000 individuals in total) covers all prescription drug expenditures related to products granted one of the government subsidies described above and 50% of all costs related to products without any government subsidy and Group 5 insurance (1.3 million individuals) that covers 50% of expenditures towards products receiving any government subsidy and 25% of costs related to products without any subsidy. Basis insurance does not cover any costs of drug purchase but individuals buying this type of insurance may – no matter their health status – opt into any of the other insurance policies at any point in time. Group 1 insurance has a yearly cost of about DKK 2,400 (in 2007), Group 2 insurance costs DKK 3,200, Group 5 insurance about DKK 1,000, and Basis about DKK 400. When we discuss our identification strategy below, we will also explicitly address the implications of this private option.

3. Conceptual Framework

In order to emphasize the identifying assumptions behind our estimation strategy and to provide a framework for interpreting our empirical results, this section firstly presents a stylised economic

[9] Individuals aged 61 or above cannot enrol either.

model of drug purchase. The model is set within the regime described in Section 3 above, where the crucial feature is that prescription drug subsidies vary with total consumption. We next discuss parameters of interest and identification.

At each point in time, an individual experiences a risk of becoming ill and an associated need to buy a given prescription drug. This risk is specific to the individual and may vary with characteristics, observable as well as unobservable, and behavior. Therefore, at each point in time, the individual must decide whether or not to purchase the drug. Since prescription drug purchase, by definition, requires a prescription from a general practitioner, only individuals who experience medically substantiated needs are able to do so. Individuals can decide to buy the drug in the amount prescribed by the general practitioner or not; he cannot decide on a different amount or an entirely different product. Because drug purchase is costly to the individual both in terms of foregone consumption and time, not all individuals may choose to buy the drug, although it is expected to alleviate pain and/or cure the disease (primary noncompliance) or individuals may take smaller amounts than what is prescribed (secondary noncompliance), for example by taking what is known as 'drug-holidays'.

Let *DP* indicate drug purchase. Assume that the payoff to buying the drug in question over and above the payoff of not doing so is U^{DP}. An individual will then purchase the drug if and only if

$$U^{DP} > 0$$

Furthermore, assume that the excess payoff is strictly decreasing in the price of the drug, *P*, (that is, in foregone consumption). Then

$$\frac{\partial Pr(DP = 1)}{\partial P} < 0$$

and, all other things being equal, individuals who receive a lower subsidy will be less likely to purchase the drug.

Price sensitivity may obviously vary with the product under consideration. It is likely that demand for drugs prescribed for serious illnesses is less price sensitive than average demand. Also, the

nature of the symptoms associated with a disease may affect price sensitivity of demand. Moreover, whether a condition is chronic or unexpected and temporary may affect demand. In fact, we expect forward looking individuals with chronic conditions to react on the *average* rather than the *marginal* price, see Keeler, Newhouse, and Phelps (1977), whereas individuals affected by an unexpected and temporary condition are more likely to react on the marginal price; in our setting, a forward looking individual with a chronic condition knows that he will need treatment for a long period and that buying today will lower the price of the product tomorrow. The same is not true (at least not to the same degree) for somebody who only expects to consume a small amount in the future. Finally, individuals with different socio-economic characteristics may react differently. We investigate some of these issues in our empirical analyses below.

3.1 Parameters of Interest and Identification Strategy

In principle, we are interested in uncovering the entire demand curve for a given prescription drug. In other words, how does the propensity to buy a given product change with the price? Unfortunately, the available data does not allow for that without strict parametric assumptions. We can, however, non-parametrically uncover parts of the demand curve by exploiting the structure of the subsidies described above.

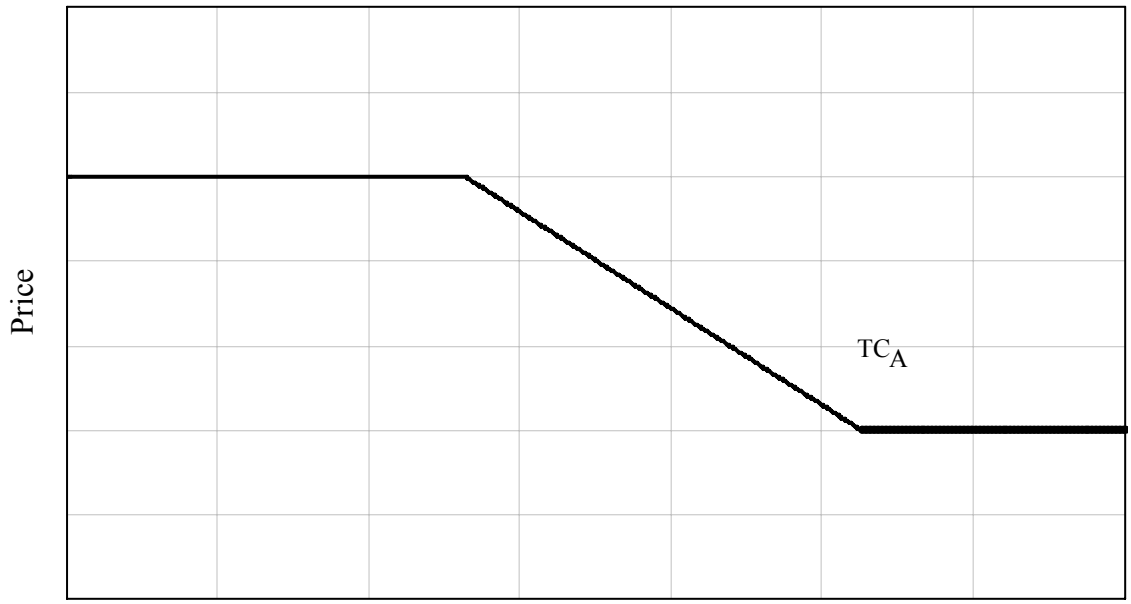
Our identification strategy relies on the fact that the subsidy scheme introduces exogenous variation in the price of a given product. Formally, denote the price without any subsidy $\overline{P}$. Clearly, given the subsidy scheme described above the price P faced by the consumer in a neighborhood of the first threshold value TC_A is

$$P = \begin{cases} \bar{P} & if\ TC < TC_A - \bar{P} \\ TC_A - TC + A(TC - \bar{P} - TC_A) & if\ TC_A - \bar{P} \leq TC < TC_A, \\ A\bar{P} & TC_A \leq TC < TC_B - \bar{P} \end{cases} \tag{1}$$

where TC is measured *prior* to the purchasing decision.

For a graphical representation, consider Figure 2. Here we depict the price faced by the consumer for different values of *TC* starting below the first threshold value TC_A.[10] For low values of *TC* the price is constant but as soon as buying the product will push *TC* above TC_A, the price decreases linearly with *TC* until the point where *TC* is exactly *at* TC_A. Hereafter the price is constant (until TC_B).

FIGURE 2



When the price is constant we obviously cannot hope to uncover any estimate of price sensitivity. Similarly, when the price changes one-to-one with *TC*, we cannot distinguish the effect of higher *TC* (and likely worse health) from the effect of lower price. What we can exploit, on the other hand, is the shift in the slope of the *P-TC* curve at TC_A, a so-called sharp *regression kink* design.[11] It is similar to a regression discontinuity design except that instead of exploiting a shift in levels, we exploit a shift in slope. In such a setting, *TC* is called a forcing variable. In the following we will describe the assumptions and mechanics behind the strategy.

[10] Threshold values *B*, *C*, and *D* give rise to similar variation in the price and the identification strategy is analogous.
[11] We cannot exploit the shift in slopes furthest to the left because we are considering a range of products with different prices and the location of the first shift clearly depends on the price of the product without subsidy.

Card, Lee and Pei (2009) formally outline the identifying assumptions behind the regression kink design. We adopt their notation. Let first W be a set of (predetermined) unobserved random variables with distribution function $G(w)$ and let the distribution and density of TC conditional on W be given by $F_{TC|W}(tc|w)$ and $f_{TC|W}(tc|w)$, respectively. Finally, let the price P be a deterministic function of TC, $P = p(TC)$; let the purchase propensity be a function of price, total costs and unobserved random variables, $Pr(DP = 1) = H(P, TC, W)$; and let predetermined observed variables $X = x(W)$.[12] X is determined before TC, which again is determined before P.

Assume the following:

(Regularity) $Pr(DP = 1)\ and\ x(W)$ are real-valued function with continuous first derivatives.

(First stage) $P = p(TC)$ is a known function that is everywhere continuous and is continuously differentiable on $(-\infty, TC_A)\ and\ (TC_A, \infty)$ but $\lim_{TC\downarrow TC_A} p'(TC) \neq \lim_{TC\uparrow TC_A} p'(TC)$. In addition, $f_{TC|W}(tc_A|w) > 0\ for\ w \in A$ where $\int_A dG(w) > 0$.

(Smooth density) $F_{TC|W}(tc|w)$ is twice continuously differentiable in tc at TC_A for every w. That is, $\frac{\partial f_{TC|W}(tc|w)}{\partial tc}$ is continuous in tc for all w.

Card, Lee and Pei (2009) show that these assumptions together imply that:

(a) $Pr(W \leq w|TC = tc)$ is continuously differentiable in tc at TC_A for all w.

(b) $\frac{\lim_{TC\downarrow TC_A} \frac{\partial E(Pr(DP=1)|TC=TC_A)}{\partial tc} - \lim_{TC\uparrow TC_A} \frac{\partial E(Pr(DP=1)|TC=TC_A)}{\partial tc}}{\lim_{TC\downarrow TC_A} \frac{\partial p(tc)}{\partial tc} - \lim_{TC\uparrow TC_A} \frac{\partial p(tc)}{\partial tc}} = E\left[\frac{\partial Pr(DP=1)}{\partial tc}|TC = TC_A\right]$

(c) $Pr(X \leq x_0|TC = tc)$ is continuously differentiable in tc at TC_A for all x_0.

Intuitively, with the above assumptions we can estimate our parameter of interest

$$(2)\ E\left[\frac{\partial Pr(DP=1)}{\partial P}|TC = TC_A\right] = \frac{\lim_{TC\downarrow TC_A} \frac{\partial E(Pr(DP=1)|TC=TC_A)}{\partial tc} - \lim_{TC\uparrow TC_A} \frac{\partial E(Pr(DP=1)|TC=TC_A)}{\partial tc}}{\lim_{TC\downarrow TC_A} \frac{\partial p(tc)}{\partial tc} - \lim_{TC\uparrow TC_A} \frac{\partial p(tc)}{\partial tc}}$$

[12] Card, Lee and Pei (2009) note that X could in principle enter $H(\cdot)$ directly. Leaving it out is without loss of generality.

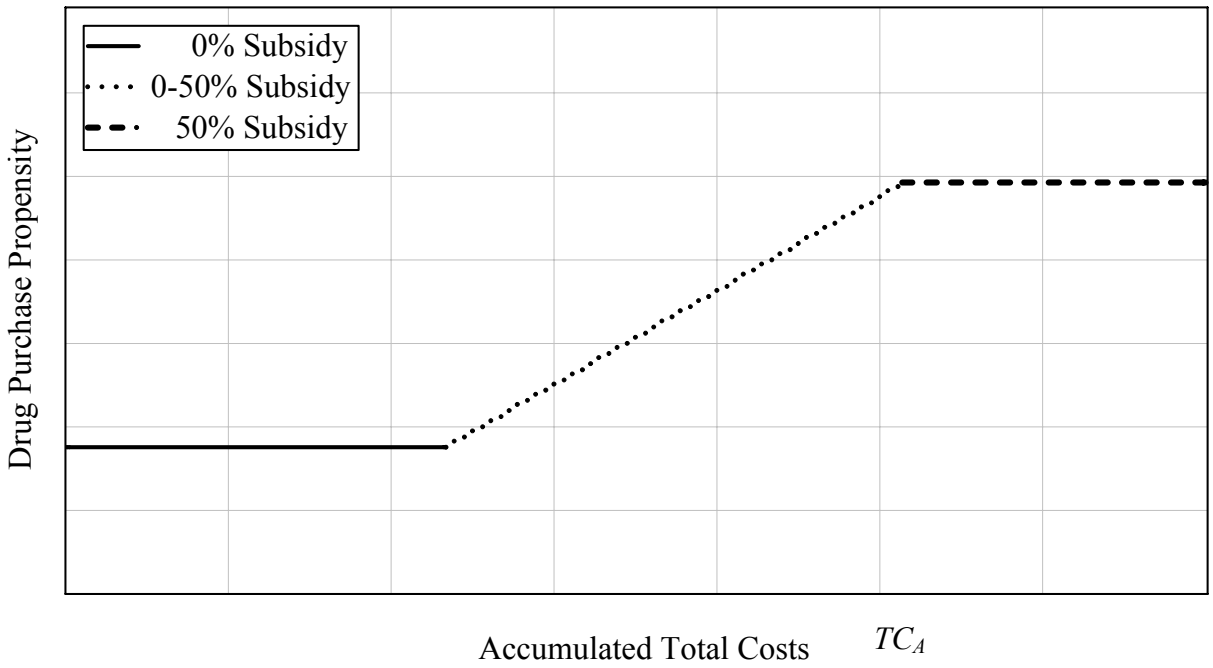
by comparing the slope of the propensity to consume with regards to *TC* for observations that are *just* to the right of TC_A with that of observations that are *just* to the left while properly correcting for the deterministic shift in the relationship between *P* and *TC*. From this parameter, we can calculate implied elasticities as well as predicted changes in *amounts* caused by changes in the price. Specifically, let *N* be the number of potential buyers and $Q = Pr(DP = 1)N$ be the quantity sold. Clearly, then the percentage change in the propensity to buy caused by a percentage change in the price just equals the classic price elasticity:

$$\varepsilon = \frac{\partial Pr(DP = 1)}{\partial P} \frac{P}{Pr(DP = 1)} = \frac{\partial Pr(DP = 1)N}{\partial P} \frac{P}{Pr(DP = 1)N} = \frac{\partial Q}{\partial P} \frac{P}{Q}$$

To give an example of our identification strategy, assume for simplicity that the propensity to purchase a given prescription drug does not depend on health and thus in the absence of the subsidy scheme would not correlate with *TC*[13] but decreases linearly in the price of the product. In this case the price variation from Figure 2 will translate into a propensity to purchase the product given in Figure 3, where we see that the subsidy scheme introduces an exogenous change in the slope of the propensity to consume at TC_A.

[13] In reality, the propensity to purchase description drugs may be correlated with *TC*. Individuals who are more often ill, for example, are more likely to have a high *TC*.

FIGURE 3



Discussion of the identifying assumptions and their implications

Apart from a set of regularity conditions, we rely on a shift in the *P*-*TC* curve at TC_A along with the assumption of smoothness of the first derivative of the density of *TC* conditional on *W*. As pointed out by Card, Lee and Pei (2009), this latter assumption is the critical one and implies that agents must not have full control of the forcing variable, *TC*. The discontinuous shift in the slope of the relationship between *P* and *TC* arises immediately from the subsidy scheme as described above.

An important implication of the identifying assumptions is (c) above, which says that any predetermined variable *X* should have a cumulative distribution function that is differentiable with respect to *TC*. In other words, there must be no kink in the distribution of *X*. Card, Lee and Pei (2009) stress that it is not enough to show that means of covariates are similar on both sides of the kink point. Here, we need to consider the empirical distribution of *X* given *TC*. Of course, this is trivially satisfied if the distribution of *X* does not vary with *TC* in a neighborhood around the kink point. This would be true, for example, if individuals do not experience a shift in health status or the propensity to take up private health insurance when their total costs increase slightly.

A second issue regarding identification concerns endogenous (or strategic) sorting with regards to *TC*. In the tax literature, individuals sometimes *bunch* at tax kink points, see Chetty et al. (2009) and Saez (2008). In that setting, bunching is optimal because higher income increases the marginal tax rate. Therefore it might be optimal to refrain from supplying an extra hour of work. We do not worry about bunching, however, since it is suboptimal in our setting. Here, a higher level of consumption weakly reduces the price faced by the consumer. We do, nonetheless, show the distribution of observations around the kink point; see below.

Interpretation of parameter of interest

The parameter we uncover is clearly local. In fact, Card, Lee and Pei (2009) demonstrate that the parameter uncovered by the regression kink design corresponds to both the 'treatment on the treated' parameter of Florens, Heckman, Meghir and Vytlacil (2008) as well as the 'local average response' of Altonji and Matzkin (2005). It can be interpreted as the expected price sensitivity around TC_A for individuals who buy drugs worth at least TC_A or about DKK 500 (circa € 70) in 2000 in a given 12-month period. Of course, this does not address the price sensitivity for individuals who rarely (or never) buy prescription drugs. Similarly, the degree of price responsiveness *for the same individual* may vary depending on the level of past consumption (i.e. health status). Thus, even if all individuals who buy drugs worth a total of DKK 500 actually end up buying drugs worth DKK TC_B or about DKK 1,200 (circa € 160) in 2000 in the same given 12-month period, the estimated price sensitivity at TC_A may differ from that at TC_B.

A second issue is that we estimate price sensitivity in the presence of private health insurance. As mentioned above, we do assume that individuals do not experience a shift in the propensity to take up private health insurance when their total costs increase slightly. Still, private health insurance matters for the interpretation of our results. Mechanically, because "Danmark" pays a fixed share of the costs to the patient, what the existence of private health insurance does is to shift the relationship between *P* and *TC*; it effectively diminishes the extent to which *P* is reduced when *TC* increases. In the extreme case where everybody subscribed to private health insurance and all costs of prescriptions drugs were covered by this insurance, demand would not be sensitive to the price at all. More generally, private health insurance reduces observed price sensitivity compared to a

regime with no private alternative. The same holds for the additional government subsidies (chronic's, terminal, and municipality specific).

3.3 Estimation

Though our parameter of interest is non-parametrically identified, for efficiency reasons we impose local parametric assumptions. We consider a small neighborhood around the threshold value and estimate the propensity to purchase using a simple probit model, where our unit of observation is whether a consumer buys prescription drugs during a given week.[14] To demonstrate, consider the following simple model where *TC* enters linearly in the index:

$$Pr(DP = 1|TC) = \Phi\left(\beta_0 + \beta_1 TC + \beta_2 1\left[TC > TC_j\right] + \beta_{12} 1\left[TC > TC_j\right] \cdot TC\right), \quad (3)$$

where *TC* is again the total cost variable, $1\left[TC > TC_j\right]$ indicates whether a purchase was done just above a given kink-point *j*, and $1\left[TC > TC_j\right] \cdot TC$ is the interaction of total cost and the kink-dummy. From the interaction term between the kink-dummy and *TC* in (2), we can calculate the (estimated) difference in the propensity to purchase caused by *TC* crossing threshold value j.[15] In practice, we investigate whether higher order terms of *TC* should be included.

In particular, take the derivative of the above expression with respect to TC to get

$$\frac{\partial Pr\left(DP = 1|1\left[TC > TC_j\right], TC\right)}{\partial tc} = \left(\beta_1 + \beta_{12} 1\left[TC > TC_j\right]\right)\varphi(\cdot)$$

Since $1\left[TC > TC_j\right]$ is dichotomous, we simply evaluate the above derivative for $1\left[TC > TC_j\right] = 1$ and $1\left[TC > TC_j\right] = 0$, and then take their difference:

[14] Whether we use a probit or a linear probability model does not change the conclusions from the analyses below.
[15] The model is estimated under the restriction that there is no jump at the kink points yet the results are not sensitive to this.

$$\frac{\partial Pr\left(DP = 1|1\left[TC > TC_j\right] = 1, TC\right)}{\partial tc} - \frac{\partial Pr\left(DP = 1|1\left[TC > TC_j\right] = 0, TC\right)}{\partial tc}$$
$$= \left(\beta_1 + \beta_{12} 1\left[TC > TC_j\right]\right)\varphi(\cdot) - \beta_1 \varphi(\cdot)$$

This is our estimate of the numerator in (2). The denominator is the difference between $\frac{\partial P}{\partial tc}$ on each side of the kink. This is immediately available from the price scheme presented above and clearly depends on the kink in question.

A couple of practical problems arise within this framework: Firstly, our identification strategy formally holds in a small neighborhood around the threshold points. In practice, we need to choose a bandwidth. The problem with comparing observations that are far away from the threshold values is, of course, that others factors beyond the difference in drug subsidy may drive the decision of drug purchase. Individuals with lower *TC* are, for example, less likely to be ill in the first place. For precisely this reason we need observations *close* to a given value of *TC*. On the other hand, we need a large number of observations. In general, a regression discontinuity design requires a large number of observations; see for example Lee and Lemieux (2009). Intuitively, a regression kink design is even more data demanding because we have to estimate not a shift in levels but a shift in the slope.

Secondly, if the price of the product under consideration (or equivalently *TC*) is 'too low' relative to the bandwidth for individuals on the left hand side of the kink, we run the risk that the price does not depend on *TC* at all; we are on the leftmost flat part of the graph in Figure 1, see also (1) above. If this is the case, we will not get a consistent estimate of our parameter of interest. In fact, if the propensity to purchase is increasing in *TC*, we will likely underestimate price sensitivity. In the example in Figure 3 above, where we for expositional purposes assume that the propensity to consume does not vary with underlying health, our estimate of the price sensitivity will be zero if we use observations on the leftmost flat part as controls, whereas it is in fact negative. Conversely, if the price is 'too high' we run the risk that individuals cross the next kink point and receive an even larger subsidy for part of the price.

In the empirical analyses below we investigate how sensitive our estimates are to the choice of bandwidth. We also investigate the distribution of prices of prescription drugs. If only a small share

of prices are lower than our bandwidth, the problem that we may partly identify of a part of the *TC* curve where the price does not depend on *TC* is of little importance. In the same way, if only a small share of prices are higher than the difference between the threshold points, the problem that individuals may cross the next threshold point is minor as well. If we, for example, consider the 50 % threshold point, prices should be below DKK 700 in 2000 to avoid this problem. Finally, we investigate results for products where the price is sufficiently large (larger than half the bandwidth) but also sufficiently small (smaller than the difference between two neighboring kink points).

Note that the fact that we need to estimate a shift in the slope of the propensity to purchase curve precludes the use of falsification tests where a 'fake' kink is investigated. Since the functional form of the curve is unknown and potentially differs between real and fake kink points, we cannot use the functional form specification from the actual kink points to investigate any fake kink points. Thus, we cannot identify whether a significant shift in the slope of the curve at a random fake kink point is just caused by misspecification.

Finally, in practice we can only meaningfully investigate price responsiveness in a neighborhood around the lowest kink point TC_A (and to some extent around TC_B). This reflects both the paucity of the data at higher kink points as well as smaller changes in subsidies.

4. Data and Descriptive Statistics

This section first describes the available data and discusses how we construct the dependent variable as well as the forcing variable. We then present a range of descriptive statistics.

We use administrative data provided by Statistics Denmark. The data set contains information on a representative sample of 20% of all Danish individuals in the period from 2000-2003. For each individual in the sample in this period we know the complete history of prescription drug purchases including date, price, amount of subsidy, type of subsidy, and type of drug. These data are augmented with socio-economic information describing demographics, income, and education on a yearly basis. Unfortunately, we do not know diagnoses, nor do we have information on unredeemed prescription notes. Thus from the perspective of the econometrician, there are no differences

between a decision not to buy after having seen a doctor and having him prescribe a product and the decision not to go to a doctor in the first place. Finally, we do not know whether an individual has private insurance. All estimates of price sensitivity are therefore estimated for potentially forward looking agents within a market where private health insurance – that may cover part of or all costs related to prescription drugs – exists. As argued above, these are also the policy relevant estimates.

In the following, we discard observations for individuals who, at the time of purchase, were below 18 years. Most importantly, the subsidy scheme described above is only valid for adults. Additionally, young individuals are perhaps more likely to have someone else pay for their prescription drugs. Thus we would not measure *their* price sensitivity.

Table 2 first shows our variables related to prescription drug purchases. The Anatomical Therapeutic Chemical (ATC) variable is a five level code for classification of drugs, which it is defined and maintained by WHO; see Table 3 for an example that explains the components of the ATC-code.[16,17] *DDD* measures the number of daily doses included on the prescription (given that the drug is used for its primary purpose). *TOS* is the type of subsidy associated with the prescription, see Section 2. *SUB* is the amount of subsidy received, while *SP* is the subsidy price mentioned in Section 2. *NAME* is the brand or the name of the company that produced the drug. The rest of the variables in Table 2 are self-explanatory.

[16] Some prescription drugs are not assigned an ATC-code. This group often consists of so-called magistral medicinal products, which are drugs produced at the pharmacy. In general, these products do not qualify for subsidy.
[17] See also Appendix A, Table A1 for a list of the twenty most common (in terms of number of purchases) therapeutic subgroups and Table A2 for the twenty largest therapeutic groups in terms of expenditure shares. Table A3 shows the twenty most commonly sold products.

TABLE 2

VARIABLES DESCRIBING DESCRIPTION DRUG PURCHASES

Variable	Description
ID	Individual identifier
NP	Number of packages purchased
ATC	Active ingredient
DDD	Defined daily doses on prescription
TOS	Type of subsidy
SUB	Amount of subsidy received
SP	Reference/subsidy price
NAME	Brand level name of drug
EDP	Exact date of purchase
TP	Total price of drug
OP	Out-of-pocket payment for drug

TABLE 3

EXAMPLE OF ATC-CODE

ATC-code	A10BA02
A	Alimentary tract and metabolism
	(1st level, main anatomical group)
A10	Drugs used to treat diabetes
	(2nd level, therapeutic subgroup)
A10B	Oral blood glucose lowering drugs
	(3rd level, pharmacological subgroup)
A10BA	Biguanides
	(4th level, chemical subgroup)
A10BA02	Metformin
	(5th level, chemical substance)

Table 4 next presents the list of variables describing socio-economic characteristics. All variables are measured in the year prior to the purchasing decision. *UEMP* specifies the fraction of working-hours in a given year spent unemployed. *INC* is before-tax income of the individual and *LINC* is before-tax labor income. We use these variables to investigate price sensitivity for different subgroups in the population.

TABLE 4

VARIABLES IN THE DATA SET

Variable	Description
ID	Individual identifier
AGE	Age
NCHILD	Number of children below the age of 18
UNEMP	Fraction of time spent unemployed
INC	Yearly income
EDUC	Highest completed education
GEN	Gender
LINC	Yearly labor income

The dependent variable

Our dependent variable is a dummy variable for prescription drug purchase in a given week. It takes the value one if an individual purchases prescription drugs and is zero otherwise. We can think of three potential groups of individuals: 'Always-takers' who buy a product regardless of the price, 'never-takers' who never buy a product and 'compliers' who buy a product if it is sufficiently cheap, see Imbens and Angrist (1994). Since we do not know whether a prescription has been filled, never-takers will likely constitute a sizeable fraction of the zeroes. On the other hand, some individuals may not even go to the doctor in the first place because of price sensitivity. Remember though, that all the individuals we are exploiting for identification purposes have, by definition, at some point during the last 12 months been to the doctor to pick up a prescription and made a purchase. The fact that we do not observe degree of need is shared with the entire literature. It is, however, innocuous in the sense that neither never-takers nor always-takers contribute to identification of the change in the propensity to buy caused by a change in the price. All the inclusion of these two groups does is to cause a parallel (downwards or upwards) shift in the propensity to purchase drugs around the kink point. As such, they do not affect the slope of the relationship between P and TC and have therefore no impact on the identification of the percentage in the propensity to buy at a change in the price either. What will be affected, however, is the estimate of the percentage change in the propensity to purchase at a percentage change in the price; the associated implied elasticity ε. The reason is that this parameter is evaluated at the average propensity to purchase; see the definition of the elasticity on page 14 above. As such, one can think of the elasticity estimate as an upper bound of the elasticity among those with a prescription.

We consider all weeks in a year so any seasonal differences in the propensity to purchase are averaged out. Note that this means that individuals may appear more than once. We account for this by clustering the standard errors at the individual level.[18] For the purpose of constructing elasticities, we consider *the first* purchase in a given week. This is done to avoid modeling the decision to buy a basket of products at the same time. It is unproblematic as long as it is random which product the pharmacist enters into the cash register as the first.

Constructing accumulated total costs, *TC*

We next need to construct the forcing variable, *TC*. As described in Section 2, *TC* is the sum of the *subsidy price* associated with each purchase over the individual's subsidy year. We have information on the date of purchase in the data as well as the subsidy price, so constructing *TC* amounts to accumulating the subsidy price for each individual for all purchases starting from March 1 2000. 365 days after the first purchase *TC* is re-zeroed. The next *TC* year starts with the first purchase after the re-zeroing.

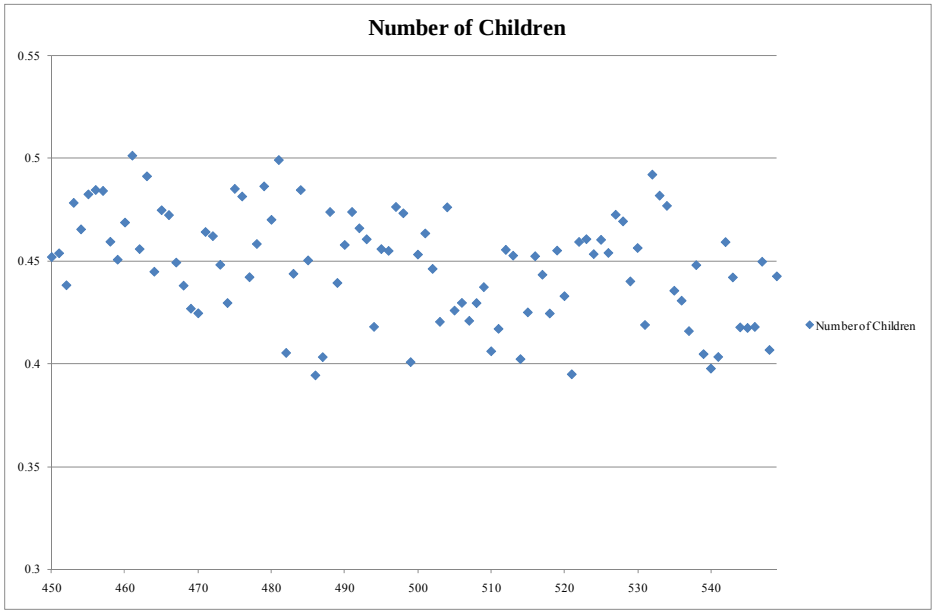
4.1 Descriptive statistics

As pointed out above, our identifying assumptions imply that any predetermined variable *X* should have a cumulative distribution function that is differentiable with respect to *TC*. I.e. there must be no kink in the distribution of *X*. Figures 4-8 show the distribution of our predetermined covariates around the 50 % subsidy kink. We consider number of children, labor income, unemployment, total income, age and education. Education is a dummy for more than 12 years of schooling. Income is measured in DKK and is discounted to year 2000. Again, all variables are measured in the year prior to the purchasing decision.

[18] The results are not sensitive to clustering. Unfortunately, we are not able to incorporate individual level fixed effects because only a very small fraction of individuals are observed to have a *TC* within the bandwidth but on each side of a given kink point.

FIGURE 4[a]

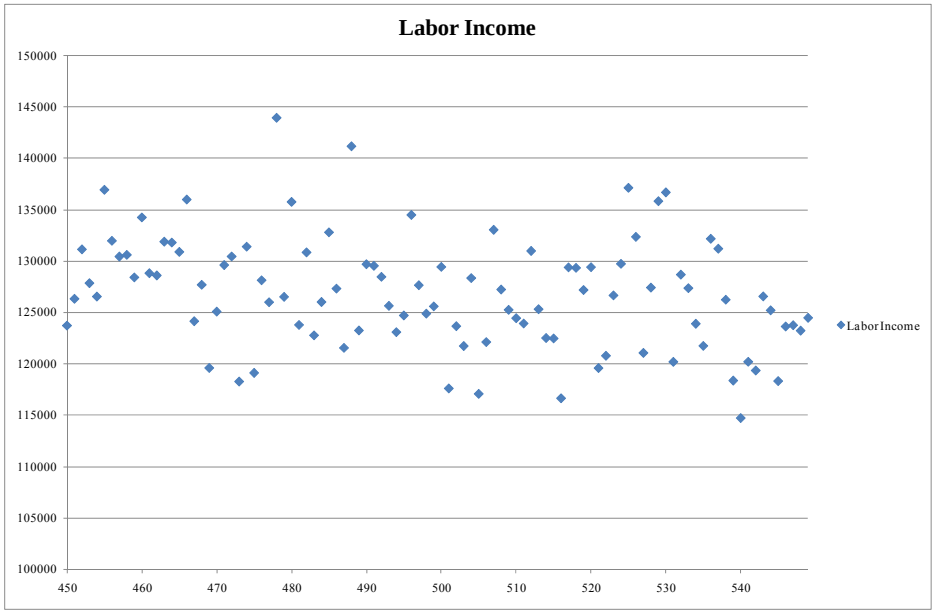
DISTRIBUTION OF NUMBER OF CHILDREN AROUND 50% SUBSIDY KINK



[a] Averages are calculated within DKK 1 bins.

FIGURE 5[a]

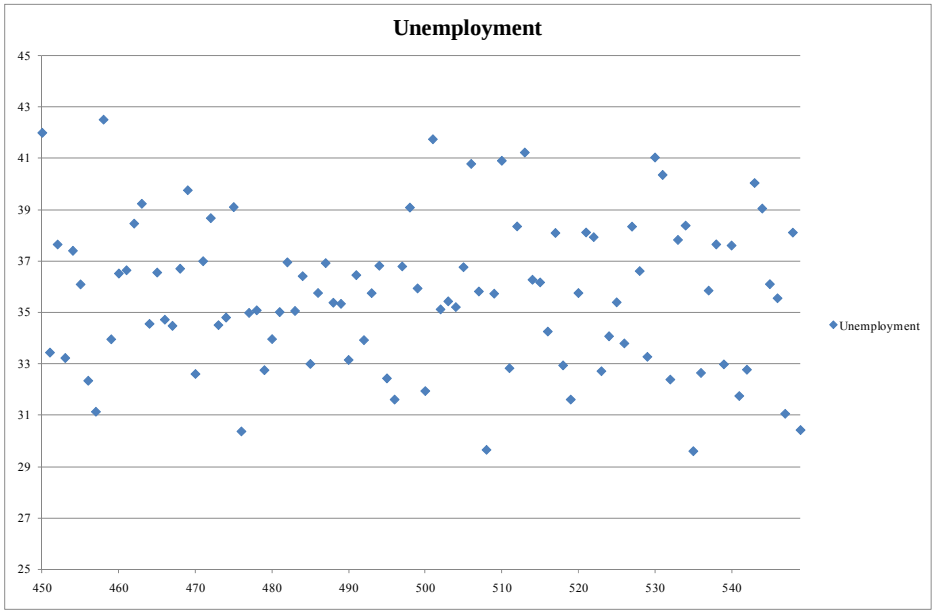
DISTRIBUTION OF LABOR INCOME AROUND 50% SUBSIDY KINK



[a] Averages are calculated within DKK 1 bins.

FIGURE 6[a]

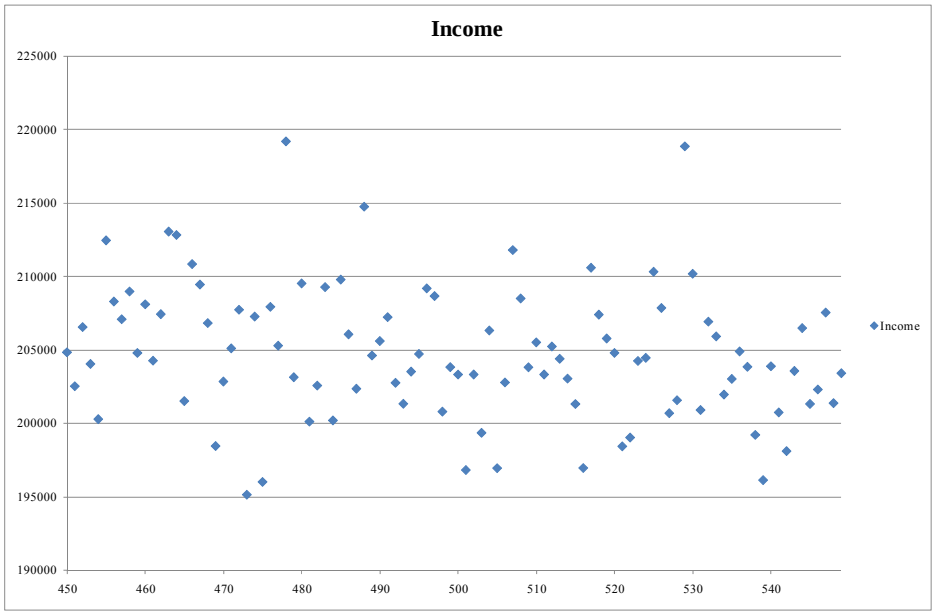
DISTRIBUTION OF DEGREE OF UNEMPLOYMENT AROUND 50% SUBSIDY KINK



[a] Averages are calculated within DKK 1 bins.

FIGURE 7[a]

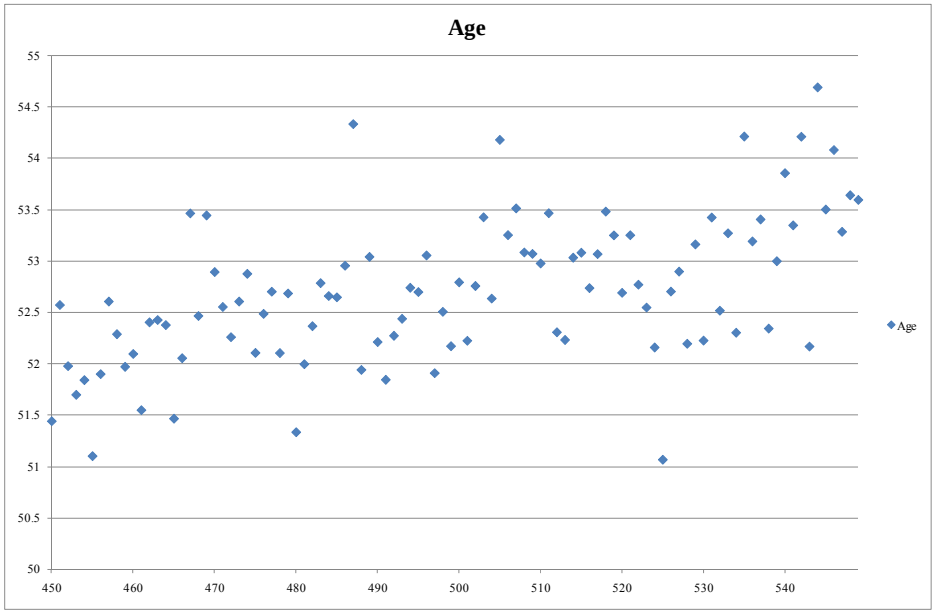
DISTRIBUTION OF INCOME AROUND 50% SUBSIDY KINK



[a] Averages are calculated within DKK 1 bins.

FIGURE 8[a]

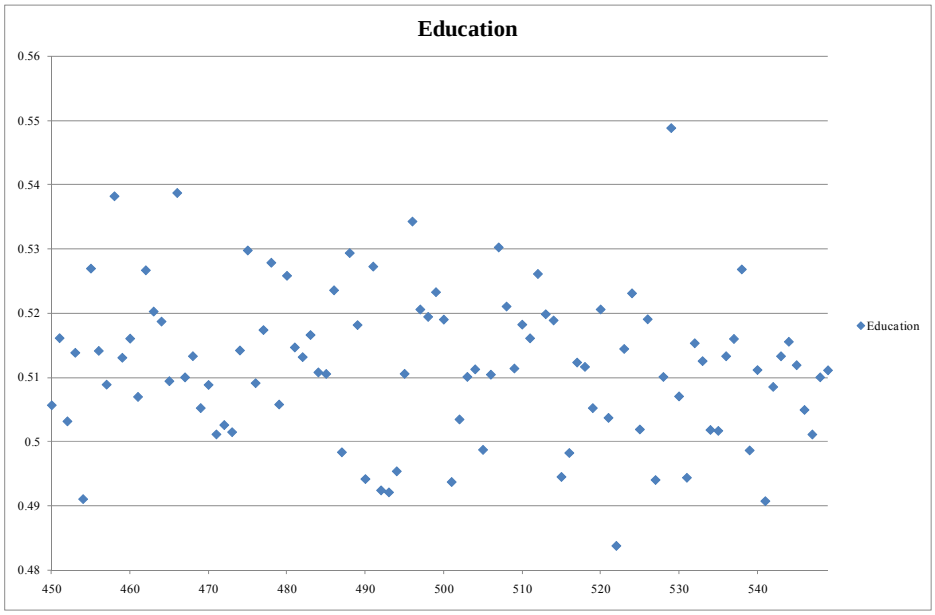
DISTRIBUTION OF AGE AROUND 50% SUBSIDY KINK



[a] Averages are calculated within DKK 1 bins.

FIGURE 9[a]

DISTRIBUTION OF EDUCATION AROUND 50% SUBSIDY KINK



[a] Averages are calculated within DKK 1 bins.

For completeness and to illustrate the role of covariates in our estimations, Tables 5 and 6 show differences in means for individuals in 2000 with a *TC* in the intervals between DKK 450-550 and DKK 475-525. Results for other years and kinks are similar and available on request. We see that some of the differences in means are statistically significant at the 5 % level when considering the DKK 450-550 interval in Table 5. Since our sample is very large (about 100,000 yearly observations in the 450-550 interval), this is expected. The differences themselves are very small.[19] Considering the DKK 475-525 interval in Table 6 renders the differences in means close to zero.

TABLE 5

DESCRIPTIVE STATISTICS ON SOCIO-ECONOMIC CHARACTERISTICS, YEAR 2000

	450<TC<500			500<TC<550			
	Mean	Std. Dev.	N	Mean	Std. Dev.	N	t-statistic
NCHILD	0.34	0.78	50,270	0.32	0.77	45,753	1.7
LINC	100,108.57	145,713.70	50,270	95,682.88	144,606.24	45,753	3.3
UEMP	30.08	125.14	50,270	30.42	127.13	45,753	-0.3
INC	185,754.94	183,015.61	50,270	183,172.47	151,168.10	45,753	1.7
AGE	56.82	18.03	50,270	57.17	18.10	45,753	-2.1
EDUC	0.55	0.50	50,270	0.56	0.50	45,753	-1.8

TABLE 6

DESCRIPTIVE STATISTICS ON SOCIO-ECONOMIC CHARACTERISTICS, YEAR 2000

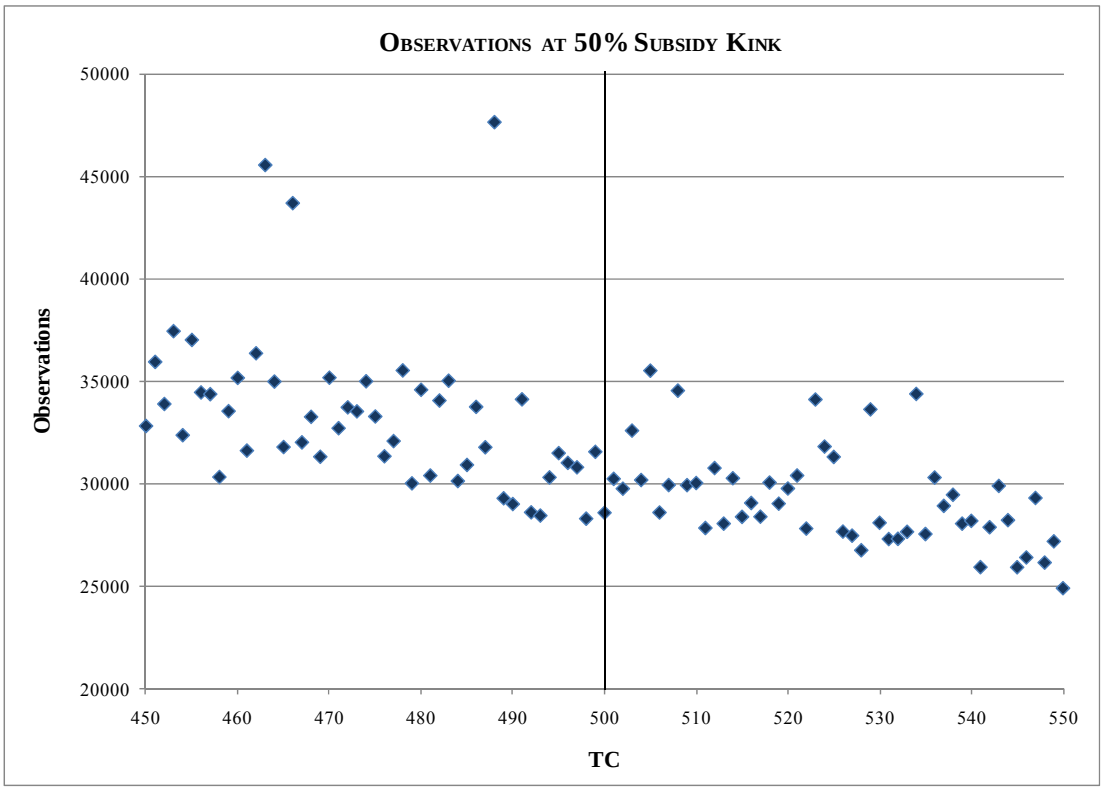
	475<TC<500			500<TC<525			
	Mean	Std. Dev.	N	Mean	Std. Dev.	N	t-statistic
NCHILD	0.33	0.78	26,036	0.31	0.75	23,727	1.6
LINC	98,637.91	146,150.81	26,036	96,013.36	141,905.25	23,727	1.4
UEMP	28.91	122.50	26,036	29.70	125.62	23,727	-0.5
INC	185,576.73	202,204.73	26,036	183,478.06	152,314.16	23,727	0.9
AGE	57.05	17.99	26,036	57.11	17.99	23,727	-0.3
EDUC	0.52	0.50	64,013	0.53	0.50	58,940	-1.5

Figure 10 shows the distribution of observations around the 50% subsidy kink. The dots show the average number of observations in DKK 1 intervals. As expected, there are no signs of bunching on either side of the kink.

[19] The sign also varies from year to year.

FIGURE 10[a]

DISTRIBUTION OF OBSERVATIONS AROUND 50% SUBSIDY KINK



[a] The average number of observations is calculated within bins of DKK 1.

As pointed out above, it is potentially important that our bandwidth is sufficiently small compared to the minimum price of prescription drugs and that the prices are not too high. Otherwise we run the risk of a downwards bias in our estimates. For this reason we investigate the distribution of prices.

Figure 11 shows the distribution of the reference/subsidy price (see Section 2 above for further details) for sales for individuals with *TC* in the DKK 450-550 interval. The subsidy price is the price that determines the size of the subsidy. Only a small share of the prices is smaller than DKK 50 and the share below DKK 10 is minuscule. This is even clearer in Figure 6 where we investigate the distribution for subsidy prices below DKK 100. Figure 5 additionally shows that only a small share of the purchases is associated with a very high price. This means that the concerns regarding bias due to "small" or "large" prices are of minor importance.

FIGURE 11

DISTRIBUTION OF REFERENCE/SUBSIDY PRICES FOR PURCHASES, *TC* IN DKK 450-550 INTERVAL

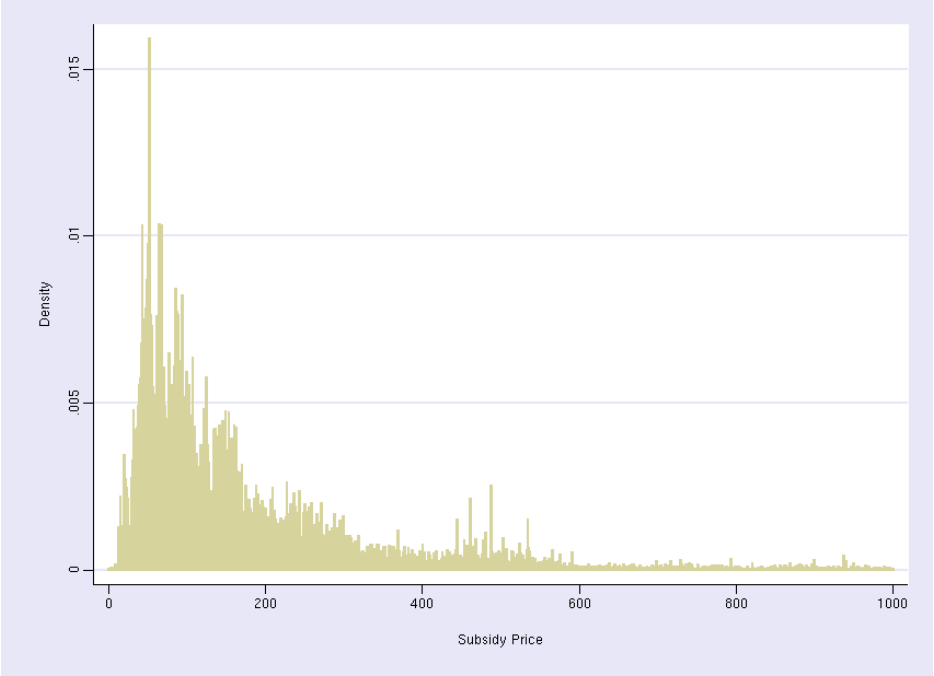
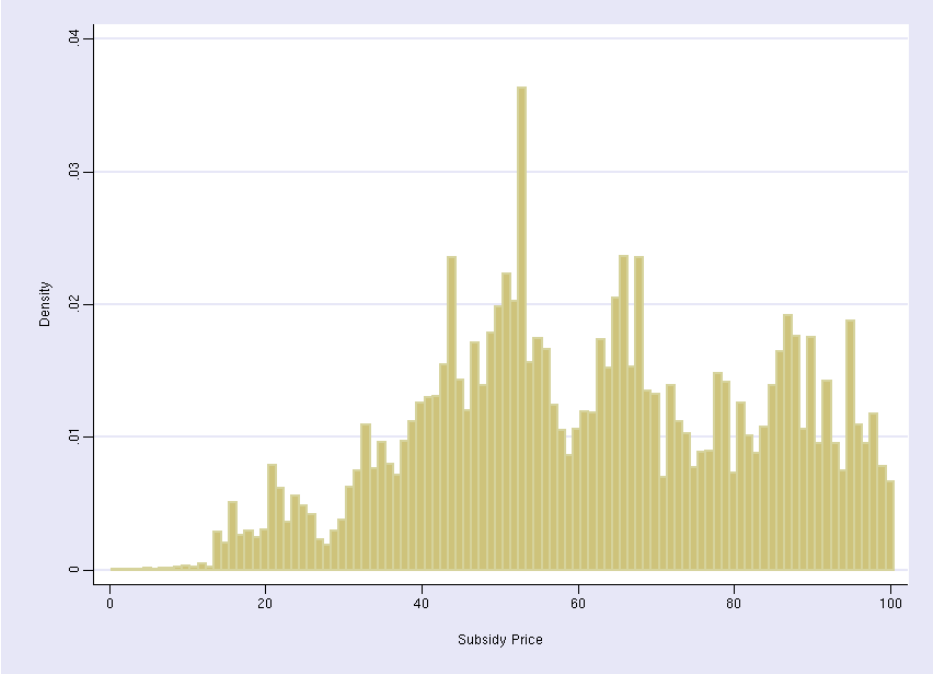


FIGURE 12

DISTRIBUTION OF REFERENCE/SUBSIDY PRICES FOR PURCHASES, *TC* IN DKK 450-550 INTERVAL

SUBSIDY PRICE BELOW DKK 100



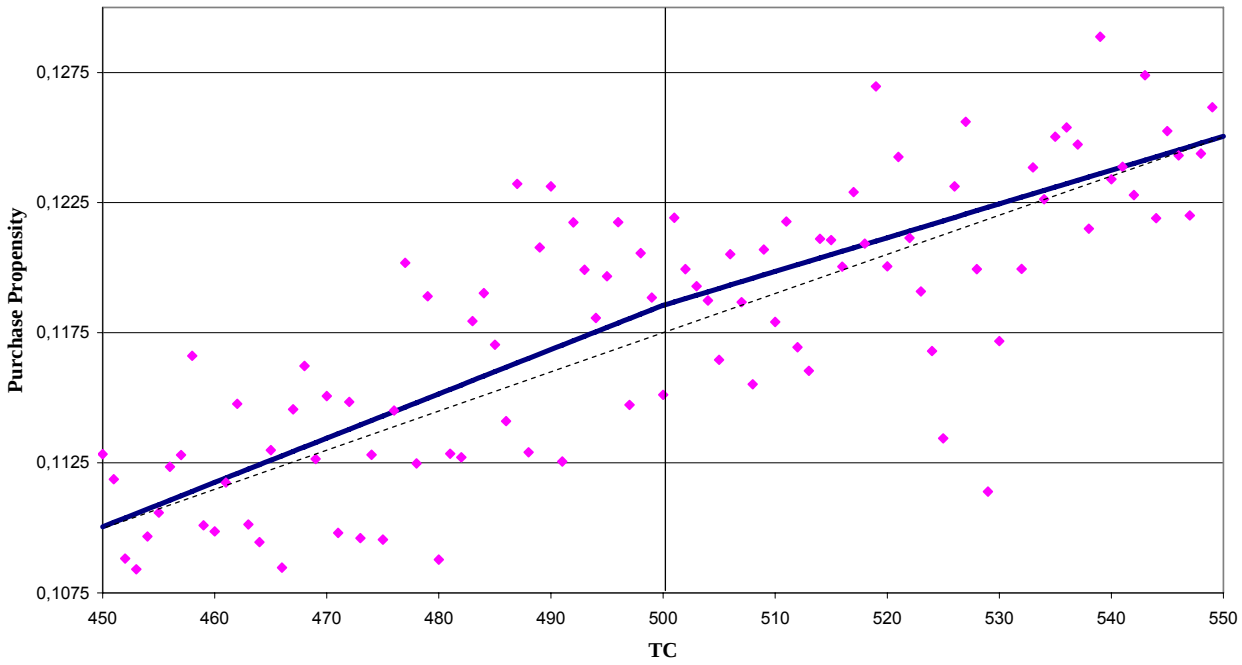
5. Results

This section presents our estimation results. As described above we model the decision to purchase prescription drugs in a given week using the probit specification outlined in Section 3 but add year dummies as well. Our main analyses consider the kink caused by the lowest subsidy (50 %). *TC* is discounted to year 2000 using the consumer price index. To secure that we correctly capture the functional form of the curve, we start out by including higher order terms of *TC* and test the model down. In practice, all models include *TC* in levels while higher order terms are insignificant.

Figure 13 shows the empirical relationship between the propensity to buy and *TC* around the lowest kink point.[20] The solid line shows the predicted values from OLS estimation of the model in Section 3, while the dots show the average purchase propensity in DKK 1 intervals. Important for our strategy, the figure indicates that there *is* a shift in the slope of the purchase propensity around the lowest kink point. This is the variation we are identifying price sensitivity off.

FIGURE 13[a]

PURCHASE PROPENSITY AT 50 % SUBSIDY KINK



[a] The average purchase propensity is calculated within bins of DKK 1. The solid line shows predicted values from OLS estimation of the model in section 3.

[20] It is the empirical equivalent to the simple model example shown in Figure 3.

Table 8 presents the results from the formal analyses for this lower kink point.[21] As mentioned above, all standard errors are clustered at the individual level. The upper part of the table shows the results using the full set of products. The estimates are small and negative and in line with those from the existing literature. The size of the estimates does vary somewhat with the bandwidth: the estimate using a bandwidth of DKK 50 yields an elasticity of -0.08; a ten percent increase in the price decreases the propensity to buy with 0.8 per cent. This estimate is significant at the 10 % level, while the estimated elasticity using a DKK 25 bandwidth is larger in size (-0.25) and significant at the 5 % level. The middle part of the table shows results when including covariates in the analyses. We condition on the variables shown in Tables 5 and 6 above: Number of children, labor income, degree of unemployment throughout the year, income, age, and an indicator for more than 12 years of education. The size of the estimated elasticity using a DKK 25 bandwidth is reduced from -0.25 to -0.18 by this exercise yet the two estimates are not significantly different from each other. The result using a DKK 50 bandwidth is unchanged by the inclusion of covariates.

The estimates might, however, have been contaminated by purchase decisions where the price is lower than the bandwidth. Similarly, if the price is 'too high' we run the risk that individuals cross the next kink point and receive an even larger subsidy for part of the price. The lower part of Table 8 shows the results where we exclude purchases where the associated price is either too low or too high in this respect. We do not find evidence that the inclusion of 'too low' or 'too high' prices biases our estimates.

[21] Results where we for example include both first and second order terms of *TC* are available on request.

TABLE 8

TREATMENT EFFECT AND IMPLIED ELASTICITIES, ALL PRODUCTS,
50 % SUBSIDY KINK, TC = DKK 500

		Treatment effect (*1,000)	S.E. (*1,000)	ε	Avg. P	Std. P	Obs.	People
(+/-)	50 DKK	*-0.11*	0.06	*-0.08*	87.96	90.28	368,497/3,136,998	263,393
	25 DKK	**-0.34**	0.17	**-0.25**	85.47	90.37	184,220/1,558,687	171,564
Include covariates								
(+/-)	50 DKK	*-0.10*	0.06	*-0.07*	87.96	90.28	368,497/3,136,998	263,393
	25 DKK	-0.23	0.16	-0.17	85.47	90.37	184,220/1,558,687	171,564
Exclude if price 'too low' or 'too high'								
(+/-)	50 DKK	*-0.10*	0.05	*-0.09*	89.18	70.61	310,779/3,136,998	263,393
	25 DKK	**-0.32**	0.14	**-0.22**	79.16	68.87	175,818/1,558,687	171,564
	10 DKK	-0.23	0.62	-0.15	75.74	68.54	71,062/613,707	81,562

Treatment effecs and implied elasticities at DKK 500 kink. S.E. clustered by Person ID. Results are not sensitive to clustering.
Avg. P is average price paid by consumers and obs. gives the number of purchases observed and the total number of observations. Italic estimates are significant at the 10 % level, bold estimates are significant at the 5 % level.
Exclude if price 'too low' or 'too high' excludes products that cost less than half the bandwith (too low price) or more than the amount that would push the consumer over the next kink (too high price).

5.1 Sensitivity analysis

As discussed above, it is unlikely that all individuals react similarly to price variation. This subsection investigates whether the estimated parameters for the 50 % subsidy threshold vary across subpopulations and investigates price sensitivity at the 75 % threshold. Table 9 shows the results where we only include individuals who exclusively receive general subsidies. That is, we exclude individuals who receive any additional subsidies as outlined in Section 2. This exercise reduces sample sizes with around 50 %. Significance is, not surprisingly, affected by this but the estimates are similar to those using the full set of products. Thus there is no evidence that individuals who receive additional subsidies are more or less sensitive to the price of prescription drugs compared to individuals who receive further subsidies.

TABLE 9

TREATMENT EFFECT AND IMPLIED ELASTICITIES, ALL PRODUCTS,
50 % SUBSIDY KINK, TC = DKK 500, GENERAL SUBSIDY ONLY

		Treatment effect (*1,000)	S.E. (*1,000)	ε	Avg. P	Std. P	Obs.	People
(+/-)	50 DKK	-0.06	0.07	-0.06	96.44	87.56	146,154/1,550,985	135,670
	25 DKK	*-0.37*	0.21	*-0.29*	93.38	86.59	72,602/612,289	81,926
Include covariates								
(+/-)	50 DKK	-0.04	0.03	-0.04	96.44	87.56	146,154/1,550,985	135,670
	25 DKK	-0.13	0.10	-0.10	93.38	86.59	72,602/612,289	81,926
Exclude if price 'too low' or 'too high'								
(+/-)	50 DKK	-0.05	0.07	-0.06	98.08	66.09	124,564/1,550,985	135,670
	25 DKK	*-0.32*	0.19	*-0.31*	87.79	65.77	69,172/766,521	81,926

Treatment effecs and implied elasticities at DKK 500 kink. S.E. clustered by Person ID. Results are not sensitive to clustering.
Avg. P is average price paid by consumers and obs. gives the number of purchases observed and the total number of observations. Italic estimates are significant at the 10 % level, bold estimates are significant at the 5 % level.
Exclude if price 'too low' or 'too high' excludes products that cost less than half the bandwith (too low price) or more than the amour that would push the consumer over the next kink (too high price).

Secondly, we consider differences in price sensitivity by level of education and income in Tables 10 and 11 and the results are striking. We distinguish between high and low level of education (12 years or less education versus more than 12 years of education) and high and low income (less than average income versus more than average income). Demand for prescription drugs for individuals with lower levels of education is more responsive to the price than demand for individuals with higher levels of education. Note that individuals with lower levels of education also pay a lower average price. Similarly, demand for individuals with less than average income is more price responsive than demand for individuals with higher than average income. There could be several explanations for these patterns; apart from potential differences in preferences for health investments, individuals with lower levels of income face tighter budget constraints, they could have less information about the importance of taking a particular drug, or they could be treated differently by doctors than individuals with higher socio-economic status. See for example Simeonova (2008).

TABLE 10

TREATMENT EFFECT AND IMPLIED ELASTICITIES, ALL PRODUCTS,
50 % SUBSIDY KINK, TC = DKK 500, BY EDUCATION

		Treatment effect (*1,000)	S.E. (*1,000)	ε	Avg. P	Std. P	Obs.	People
<12 yrs								
(+/-)	50 DKK	**-0.27**	0.09	**-0.16**	79.13	85.21	199,865/1,529,336	136,859
	25 DKK	*-0.41*	0.25	*-0.24*	76.90	84.84	100,144/758,851	89,783
>12 yrs								
(+/-)	50 DKK	0.03	0.08	0.03	98.42	94.89	168,632/1,607,662	127,730
	25 DKK	-0.24	0.22	-0.22	95.68	95.56	84,076/799,836	82,229
Include covariates								
<12 yrs								
(+/-)	50 DKK	**-0.10**	0.05	**-0.06**	79.13	85.21	199,865/1,529,336	136,859
	25 DKK	-0.06	0.13	-0.03	76.90	84.84	100,144/758,851	89,783
>12 yrs								
(+/-)	50 DKK	-0.01	0.03	-0.01	98.42	94.89	168,632/1,607,662	127,730
	25 DKK	-0.16	0.10	-0.14	95.68	95.56	84,076/799,836	82,229
Exclude if price 'too low' or 'too high'								
<12 yrs								
(+/-)	50 DKK	**-0.25**	0.08	**-0.19**	81.18	69.26	167,011/1,529,336	136,859
	25 DKK	*-0.40*	0.21	*-0.23*	71.65	67.09	95,860/758,851	89,783
>12 yrs								
(+/-)	50 DKK	0.04	0.07	0.04	98.48	71.03	143,768/1,607,662	127,730
	25 DKK	-0.21	0.19	-0.19	88.17	69.89	79,958/799,836	82,229

Treatment effecs and implied elasticities at DKK 500 kink. S.E. clustered by Person ID. Results are not sensitive to clustering.
Avg. P is average price paid by consumers and obs. gives the number of purchases observed and the total number of observations. Italic estimates are significant at the 10 % level, bold estimates are significant at the 5 % level.
Exclude if price 'too low' or 'too high' excludes products that cost less than half the bandwith (too low price) or more than the amount that would push the consumer over the next kink (too high price).

TABLE 11

TREATMENT EFFECT AND IMPLIED ELASTICITIES, ALL PRODUCTS,
50 % SUBSIDY KINK, TC = DKK 500, BY INCOME

		Treatment effect (*1,000)	S.E. (*1,000)	ε	Avg. P	Std. P	Obs.	People
Low Income								
(+/-)	50 DKK	**-0.20**	0.08	**-0.12**	80.51	86.26	256,373/1,965,881	179,990
	25 DKK	**-0.51**	0.22	**-0.31**	78.30	86.33	128,228/976,665	117,090
High Income								
(+/-)	50 DKK	0.01	0.09	0.01	104.96	96.63	111,657/1,165,187	93,180
	25 DKK	0.00	0.24	0.00	101.88	96.85	55,761/579,050	58,218
Include covariates								
Low Income								
(+/-)	50 DKK	**-0.09**	0.04	**-0.05**	80.51	86.26	256,373/1,965,881	179,990
	25 DKK	*-0.17*	0.10	*-0.10*	78.30	86.33	128,228/976,665	117,090
High Income								
(+/-)	50 DKK	0.01	0.04	0.01	104.96	96.63	111,657/1,165,187	93,180
	25 DKK	-0.02	0.12	-0.02	101.88	96.85	55,761/579,050	58,218
Exclude if price 'too low' or 'too high'								
Low Income								
(+/-)	50 DKK	**-0.19**	0.07	**-0.14**	82.33	69.27	214,756/1,965,881	155,930
	25 DKK	**-0.49**	0.19	**-0.29**	72.74	67.07	122,584/976,665	97,704
High Income								
(+/-)	50 DKK	0.04	0.08	0.05	104.49	71.15	95,625/1,165,187	80,631
	25 DKK	0.04	0.21	0.04	93.92	70.63	53,015/579,050	48,895

Treatment effecs and implied elasticities at DKK 500 kink. S.E. clustered by Person ID. Results are not sensitive to clustering.
Avg. P is average price paid by consumers and obs. gives the number of purchases observed and the total number of observations. Italic estimates are significant at the 10 % level, bold estimates are significant at the 5 % level.
Exclude if price 'too low' or 'too high' excludes products that cost less than half the bandwith (too low price) or more than the amount that would push the consumer over the next kink (too high price).

Table 12 shows the results for three age groups: individuals under the age of 30, individuals aged 31-64, and individuals aged 65 or above. Young individuals are literally insensitive to the price; the estimates are close to zero and insignificant. Older individuals, on the other hand, are more sensitive to the price of the product. One explanation for this pattern is simply life expectancy; if one does not expect to live much longer, it may not pay off to invest much in health either; see the seminal work by Grossman (1972) on health and Becker (1964) on human capital investments more generally. Another explanation could be that the elderly population aged 65 or above also has lower levels of income though they also have higher accumulated wealth.

TABLE 12

TREATMENT EFFECT AND IMPLIED ELASTICITIES, ALL PRODUCTS,
50 % SUBSIDY KINK, TC = DKK 500, BY AGE

		Treatment effect (*1,000)	S.E. (*1,000)	ε	Avg. P	Std. P	Obs.	People
< 30 years								
(+/-)	50 DKK	0.00	0.14	0.00	92.08	89.13	26,837/353,920	26,698
	25 DKK	-0.02	0.39	-0.03	89.89	89.77	13,422/176,284	16,315
30-64 years								
(+/-)	50 DKK	-0.07	0.07	-0.07	95.19	93.17	206,323/1,945,490	155,256
	25 DKK	*-0.34*	0.20	*-0.29*	92.47	93.70	103,069/966,466	100,072
65+ years								
(+/-)	50 DKK	**-0.27**	0.12	**-0.13**	76.12	84.63	135,337/837,588	86,484
	25 DKK	-0.19	0.34	-0.09	73.95	83.94	67,729/415,937	57,134
Include covariates								
< 30 years								
(+/-)	50 DKK	-0.01	0.07	-0.01	92.08	89.13	26,837/353,920	26,698
	25 DKK	0.00	0.20	0.00	89.89	89.77	13,422/176,284	16,315
30-64 years								
(+/-)	50 DKK	-0.03	0.03	-0.03	95.19	93.17	206,323/1,945,490	155,256
	25 DKK	*-0.17*	0.10	*-0.15*	92.47	93.70	103,069/966,466	100,072
65+ years								
(+/-)	50 DKK	**-0.12**	0.06	**-0.06**	76.12	84.63	135,337/837,588	86,484
	25 DKK	-0.05	0.17	-0.02	73.95	83.94	67,729/415,937	57,134
Exclude if price 'too low' or 'too high'								
< 30 years								
(+/-)	50 DKK	-0.01	0.13	-0.02	94.70	67.47	22,348/353,920	26,698
	25 DKK	0.07	0.33	0.09	84.27	66.51	12,672/176,284	16,315
30-64 years								
(+/-)	50 DKK	-0.05	0.06	-0.06	96.37	70.76	174,898/1,945,490	155,256
	25 DKK	*-0.28*	0.17	*-0.23*	85.97	69.66	98,029/966,466	100,072
65+ years								
(+/-)	50 DKK	**-0.27**	0.11	**-0.15**	77.02	69.33	113,533/837,588	86,484
	25 DKK	-0.29	0.32	-0.12	67.91	66.63	65,117/415,937	57,134

Treatment effecs and implied elasticities at DKK 500 kink. S.E. clustered by Person ID. Results are not sensitive to clustering.
Avg. P is average price paid by consumers and obs. gives the number of purchases observed and the total number of observations. Italic estimates are significant at the 10 % level, bold estimates are significant at the 5 % level.
Exclude if price 'too low' or 'too high' excludes products that cost less than half the bandwith (too low price) or more than the amount that would push the consumer over the next kink (too high price).

A fourth sensitivity analysis distinguishes between essential and other types of drugs (the complement set). Essential drugs are defined as "medications that prevent deterioration in health or prolong life and would not likely be prescribed in the absence of a definitive diagnosis", Tamblyn et al. (2001), page 422. See Table B2 in Appendix B for the list of drugs included in the essential category. As expected, demand for essential drugs is less price responsive than demand for other

types of drugs. Note though that the complement set of drugs may also include drugs that in some cases – but not always – fit the definition of essential drugs. One example is antibiotics.

TABLE 13

TREATMENT EFFECT AND IMPLIED ELASTICITIES

50 % SUBSIDY KINK, TC = DKK 500, BY DRUG TYPE

		Treatment effect (*1,000)	S.E. (*1,000)	ε	Avg. P	Std. P	Obs.	People
Essential								
(+/-)	50 DKK	0.00	0.03	-0.01	101.55	103.30	107,496/3,136,998	263,393
	25 DKK	-0.12	0.09	-0.35	99.29	103.45	53,541/1,558,687	171,564
Other								
(+/-)	50 DKK	**-0.12**	0.05	**-0.29**	82.39	83.76	261,308/3,136,998	263,393
	25 DKK	*-0.22*	0.14	*-0.52*	79.84	83.83	130,838/1,558,687	171,564
Include covariates								
Essential								
(+/-)	50 DKK	0.00	0.01	0.01	101.55	103.30	107,496/3,136,998	263,393
	25 DKK	-0.04	0.04	-0.11	99.29	103.45	53,541/1,558,687	171,564
Other								
(+/-)	50 DKK	**-0.06**	0.02	**-0.14**	82.39	83.76	261,308/3,136,998	263,393
	25 DKK	-0.08	0.06	-0.19	79.84	83.83	130,838/1,558,687	171,564
Exclude if price 'too low' or 'too high'								
Essential								
(+/-)	50 DKK	0.03	0.03	0.09	100.55	81.54	90,254/3,136,998	263,393
	25 DKK	-0.10	0.08	-0.28	89.30	79.89	50,799/1,558,687	171,564
Other								
(+/-)	50 DKK	**-0.11**	0.04	**-0.14**	84.53	65.05	220,525/3,136,998	263,393
	25 DKK	*-0.22*	0.12	*-0.21*	75.04	63.39	125,019/1,558,687	171,564

Treatment effecs and implied elasticities at DKK 500 kink. S.E. clustered by Person ID. Results are not sensitive to clustering.
Avg. P is average price paid by consumers and obs. gives the number of purchases observed and the total number of observations. Italic estimates are significant at the 10 % level, bold estimates are significant at the 5 % level.
Exclude if price 'too low' or 'too high' excludes products that cost less than half the bandwith (too low price) or more than the amount that would push the consumer over the next kink (too high price).

We finally investigate the 75 % subsidy kink. The estimated treatment effects are still negative and slightly smaller in size. Only the result for the DKK 50 bandwidth is statistically significant. Because of more limited sample sizes (the number of observations is reduced to around 40 % when we move from the 50 % subsidy kink to the 75 % subsidy kink) and a lower change in the subsidy at the higher kink we refrain from performing subgroup specific analyses.

TABLE 14

TREATMENT EFFECT AND IMPLIED ELASTICITIES, ALL PRODUCTS,
75 % SUBSIDY KINK, TC = DKK 1,200

		Treatment effect (*1,000)	S.E. (*1,000)	ε	Avg. P	Std. P	Obs.	People
(+/-)	50 DKK	**-0.43**	0.20	**-0.15**	60.76	72.88	218,736/1,289,790	168,086
	25 DKK	-0.45	0.56	-0.16	59.76	73.71	109,218/639,732	104,591
Include covariates								
(+/-)	50 DKK	**-0.11**	0.05	**-0.04**	60.76	72.88	218,736/1,289,790	168,086
	25 DKK	-0.15	0.14	-0.05	59.76	73.71	109,218/639,732	104,591
Exclude if price 'too low' or 'too high'								
(+/-)	50 DKK	**-0.40**	0.19	**-0.17**	65.03	68.67	195,700/1,289,790	168,086
	25 DKK	-0.50	0.56	-0.17	56.66	62.78	105,841/639,732	104,591

Treatment effecs and implied elasticities at DKK 500 kink. S.E. clustered by Person ID.

Avg. P is average price paid by consumers and obs. gives the number of purchases observed and the total number of observations. Italic estimates are significant at the 10 % level, bold estimates are significant at the 5 % level.

Exclude if price 'too low' or 'too high' excludes products that cost less than half the bandwith (too low price) or more than the amount that would push the consumer over the next kink (too high price).

Our results are not directly comparable to those from the RAND HIE (see Manning et al. (1987) and Newhouse (1993)) since that study considered – for the non-aged population – total health care utilization and not only prescription drugs. Our results, on the other hand, are local in the sense that they are estimated around the 50 % subsidy kink point. Using a similarly aged population our results are, nonetheless, fairly close in size to those from the RAND HIE. Our study does suggest that the elderly population is more responsive to the price than the non-elderly but the results are much more in line with the Canadian study by Contoyannis et al. (2005) who find moderate price elasticities (-0.12 to -0.16) than with the US study by Chandra et al. (forthcoming) that finds large and in some specifications even elastic demand (elasticities -0.20 to -1.4).[22] An obvious explanation for these differences are differences between welfare systems but also the fact that Chandra et al. (forthcoming) use data on former public sector employees may impact on the results. As suggested by Tamblyn et al. (2001) we find that demand for essential drugs is less sensitive to the price than less essential drugs.

[22] Chandra et al. (forthcoming) argue that the products with elastic demand are those for which consumers can easily substitute into other treatments.

6. Conclusion

We estimate price sensitivity of demand for prescription drugs exploiting truly exogenous variation in the price that stems from a kinked reimbursement scheme. Within a unifying framework, we are able to address this question for different subpopulations and types of drugs. We find that demand is indeed sensitive to the price, although estimated implied elasticities are small; the overall elasticity ranges between -0.08 and -0.25 for individuals who have, so far, bought prescription drugs worth at least DKK 500 (€ 70) in a given 12-month period. There is important variation in which subgroups are affected by the price of prescription drugs. Individuals with lower income and lower education are, despite (or maybe because of) their lower average health capital, more sensitive to the price of a product. The same is true for the elderly population. Thus, policy makers should be aware that reductions in subsidies for these groups are likely to result in lower consumption and, presumably, worse health outcomes. Along similar lines, lower consumption of prescription drugs may increase the take-up of inpatient and outpatient case; see for example Chandra et al. (forthcoming) and Gaynor, Li, and Vogt (2006) for evidence of this behavior. Finally, essential drugs that surely prevent deterioration of health and keep patients alive have, as expected, much lower associated average price sensitivity than other drugs.

Literature

Altonji, J. G. and R. L: Matzkin (2005): Cross Section and Panel Data Estimators for Nonseparable Models with Endogenous Regressors, *Econometrica* 73, 1053-1102.

Becker, G. S. (1964): *Human Capital*. New York: Columbia University Press.

Card, D., D. S. Lee and Z. Pei (2009), "Quasi-Experimental Identification and Estimation in the Regression Kink Design", Princeton University, WP # 553.

Chandra, A., J. Gruber, J. and R. McKnight (forthcoming): "Patient Cost-sharing, Hospitalization Offsets, and the Design of Optimal Health Insurance for the Elderly", *American Economic Review*.

Chetty, R., J. N. Friedman, T. Olsen, and L. Pistaferri (2009): The Effect of Adjustment Costs and Institutional Constraints on Labor Supply Elasticities: Evidence from Denmark. Mimeo, Harvard University.

Contoyannis, P., J. Hurley, P. Grootendorst, S. Jeon and R. Tablyn (2005): "Estimating the price elasticity of expenditure for prescription drugs in the presence of non-linear price schedules: an illustration from Quebec, Canada", *Health Economics* 14, 909-923.

Dynarski, S., J. Gruber and D. Li (2009): Cheaper by the dozen: using sibling discounts at catholic schools to estimate the price elasticity of private school attendance. NBER WP # 15461.

Florens, J. P., J. J. Heckman, C. Meghir and E. J. Vytlacil (2008), "Identification of Treatment Effects Using Control Functions in Models with Continuous, Endogenous Treatment and Heterogenous Effects", *Econometrica* 76, 1191-1206.

Gaynor, M., J. Li and W. B. Vogt (2007): Is drug coverage a free lunch? Cross-price elasticities and the design of prescription drug benefits, NBER WP #12758.

Goldman, D. P., G. F. Joyce, J. J. Escarce, J. E. Pace, M. D. Solomon, M. Laouri, P. B. Landsman, and M. Teutsch (2004): "Pharmacy Benefits and the Use of Drugs by the Chronically Ill", *Journal of the American Medical Association* 291, 2344-2350.

Grossman, M. (1972): "On the Concept of Health Capital and the Demand for Health", *Journal of Political Economy* 80, 223-255.

Guryan, J. (2003): Does Money Matter: Regression-Discontinuity Estimates from Education Finance Reform in Massachusetts", NBER WP # 8269.

Hahn, J., P. Todd and W. van der Klaauw (2001): "Identification and Estimation of Treatment Effects with a Regression-Discontinuity Design", *Econometrica* 69, 201-209.

Keeler, E. B., J. P. Newhouse, and C. E. Phelps (1977): "Deductibles and the Demand for Medical Care Services: the Theory of a Consumer Facing a Variable Price Schedule under Uncertainty", *Econometrica* 45, 641-655.

Landsman, P. B., W. Yu, X. F. Liu, S. M. Teutsch and M. L. Baerger (2005): Impact of 3-Tier Pharmacy Benefit Design and Increased Consumer Cost-sharing on Drug Utilization. *The American Journal of Managed Care* 11, 621-628.

Lee, D. S. and T. Lemieux (forthcoming): Regression Discontinuity Designs in Economics, *Journal of Economic Literature*.

Manning, W. G., J. P. Newhouse, N. Duan, E. B. Keeler, A. Leibowitz, and M. S. Marquis (1987): Health Insurance and the Demand for Medical Care: Evidence from a Randomized Experiment. *The American Economic Review* 77, 251-277.

Moffitt, Robert (1990): The Econometrics of Kinked Budget Constraints. *Journal of Economic Perspectives* 4, 119-139.

Newhouse, J. (1993): *Free for All: Lessons from the RAND Health Insurance Experiment*. Cambridge, MA. Harvard University Press.

Nielsen, H. S., T. Sørensen and C. Taber (forthcoming): Estimating the Effect of Student Aid on College Enrollment: Evidence from a Government Grant Policy Reform. *American Economic Journal: Economic Policy*.

OECD (2009): Health at a Glance 2009: OECD Indicators.

Rothstein, J. and C. Rouse (2007): Constrained after College: Student Loans and Early Career Occupational Choices, NBER WP #13117.

Saez, E. (2009): Do Tax Filers Bunch at Kink Points? Evidence, Elasticity Estimation, and Salience Effects. Mimeo, University of California at Berkeley.

Simeonova, E. (2008): Doctors, Patients, and the Racial Mortality Gap: What are the Causes? Mimeo, University of Stockholm.

Skipper, N. (2009): How Utilization of Prescription Drugs Change when Consumer Copayments Increase: Heterogeneity across Types of Drugs. Mimeo, Aarhus University.

Tamblyn, R., R. Laprise, J. A. Hanley et al. (2001): Adverse Events Associated with Prescription Drug Cost-Sharing among Poor and Elderly Persons, *Journal of the American Medical Association* 285, 421-429.

Appendix A

TABLE A1

THE 20 MOST FREQUENTLY USED THERAPEUTIC GROUPS

ATC-group	Count	Percent	Name
N05	2,538,410	9.3%	Psycholeptics
N02	2,515,002	9.2%	Analgesics
G03	1,883,471	6.9%	Sex hormones and modulators of the genital system
J01	1,730,247	6.3%	Antibacterial agents for systemic use
R03	1,720,373	6.3%	Obstructive airway disease agents
M01	1,387,090	5.1%	Anti-inflammatory and anti-rheumatic agents
C03	1,216,623	4.4%	Diuretics
N06	1,213,187	4.4%	Psycho analeptics
S01	1,056,132	3.9%	Ophthalmologics
C09	969,884	3.5%	Agents that exert an action on the renin-angiotensin system
A02	884,389	3.2%	Agents that exert an action on acid related disorders
C07	727,287	2.7%	Beta blocking agents
B01	720,792	2.6%	Anti-thrombotic drugs
A10	691,968	2.5%	Anti-diabetics
C08	654,489	2.4%	Calcium channel blockers
D07	603,136	2.2%	Corticosteroids for dermatological use
C01	537,727	2.0%	Cardiac therapy
A12	441,297	1.6%	Mineral supplements
C10	437,885	1.6%	Lipid modifying agents
R05	421,115	1.5%	Cough and cold preparations

Statistics Denmark. Purchases in period March 1st 2000-2003, age 18 and above, 20% sample.

As can be seen from Table A1, the type of drug most frequently used is psycholeptic drugs (antipsychotics). The second most frequently purchased type of drugs belongs to the analgesics category (pain relievers). This category covers products for severe pain (e.g. morphine) to over-the-counter products such as Panodil/Tylenol (mild pain relievers would qualify for conditional subsidy). In third place are sex hormones and modulators of the genital system.

TABLE A2

THERAPEUTIC GROUPS BY EXPENDITURES

ATC-group	Total[b]	Percent	Name
R03	583.21	9.4%	Obstructive airway disease agents
N06	540.92	8.7%	Psycho analeptics
N02	485.86	7.9%	Analgesics
N05	416.05	6.7%	Psycholeptics
C09	384.01	6.2%	Agents that exert an action on the renin-angiotensin system
A02	363.43	5.9%	Agents that exert an action on acid related disorders
G03	347.65	5.6%	Sex hormones and modulators of the genital system
C10	294.26	4.8%	Lipid modifying agents
C08	285.55	4.6%	Calcium channel blockers
M01	220.28	3.6%	Anti-inflammatory and anti-rheumatic agents
N03	196.26	3.2%	Antiepileptics
A10	190.24	3.1%	Anti-diabetics
J01	181.32	2.9%	Antibacterial agents for systemic use
G04	144.35	2.3%	Urologicals
C07	127.90	2.1%	Beta blocking agents
C03	126.18	2.0%	Diuretics
S01	122.16	2.0%	Ophthalmologics
B01	94.63	1.5%	Anti-thrombotic drugs
N04	74.03	1.2%	Anti-Parkinson drugs
C01	72.45	1.2%	Cardiac therapy

Statistics Denmark. Purchases in period March 1st 2000-2003, age 18 and above, 20% sample.

[b] In million DKK. 2000 prices.

Table A2 shows therapeutic groups by expenditure shares. Here, obstructive airway disease agents (asthma medicine) dominate with psychoanaleptics (anti-depressants and ADHD drugs) and analgesics in second and third place.

Finally, Table A3 shows the 20 most frequently sold *products*. Here, we exploit the full ATC-code level. As can be seen, phenoxymethylpenicillin (penicillin) is the single most prescribed drug, claiming about 2.5 % of total sales. The second most sold product is paracetamol, which is a pain reliever. In third and fourth place are ibuprofen (used for anti-inflammatory and anti-rheumatic purposes) and Tramadol (a pain-reliever).

TABLE A3

THE 20 MOST SOLD PRODUCTS BY ATC-CODE

ATC	Count	Percent	Name
J01CE02	701,131	2.6%	Phenoxymethylpenicillin
N02BE01	698,499	2.6%	Paracetamol
M01AE01	530,563	1.9%	Ibuprofen
N02AX02	503,580	1.8%	Tramadol
C03AB01	495,914	1.8%	Bendroflumethiazid and potassium
C03CA01	461,611	1.7%	Furosemide
B01AC06	406,307	1.5%	Acetylsalicylic acid
G03AA10	402,766	1.5%	Gestodene and estrogen
A12BA01	387,657	1.4%	Potassium chloride
N06AB04	375,156	1.4%	Citalopram
N05BA01	371,741	1.4%	Diazepam
N05CF01	362,669	1.3%	Zopiclone
C07AB02	354,240	1.3%	Metoprolol
C08CA01	322,811	1.2%	Amlodipin
N05BA04	305,946	1.1%	Oxazepam
M01AB05	294,313	1.1%	Diclofenac
G03CA03	280,244	1.0%	Estradiol
R03BA02	254,655	0.9%	Budesonid
R03AC02	251,607	0.9%	Salbutamol
R03AC03	249,014	0.9%	Terbutaline

Statistics Denmark. Purchases in period March 1st 2000-2003, age 18 and above, 20% sample.

Appendix B

TABLE B1

ESSENTIAL DRUGS

Essential drugs:	Insulin, anticoagulants, angiotensin-converting enzyme inhibitors, lipid-reducing medication, antihypertensives, furosemide, B-blockers, antiarrhythmics, aspirin, antiviral medication, thyroid medication, neuroleptics, antidepressants, anticonvulsants, antiparkinsonian drugs, prednisone, β-agonists, inhaled steroids, chloroquines, primaquines, and cyclosporine.

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