



RUHR

ECONOMIC PAPERS

Magdalena A. Stroka

Drug Oversupply in Nursing Homes An Empirical Evaluation of Administrative Data

RUHR
UNIVERSITÄT
BOCHUM

RUB



#475

Imprint

Ruhr Economic Papers

Published by

Ruhr-Universität Bochum (RUB), Department of Economics
Universitätsstr. 150, 44801 Bochum, Germany

Technische Universität Dortmund, Department of Economic and Social Sciences
Vogelpothsweg 87, 44227 Dortmund, Germany

Universität Duisburg-Essen, Department of Economics
Universitätsstr. 12, 45117 Essen, Germany

Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI)
Hohenzollernstr. 1-3, 45128 Essen, Germany

Editors

Prof. Dr. Thomas K. Bauer

RUB, Department of Economics, Empirical Economics
Phone: +49 (0) 234/3 22 83 41, e-mail: thomas.bauer@rub.de

Prof. Dr. Wolfgang Leininger

Technische Universität Dortmund, Department of Economic and Social Sciences
Economics – Microeconomics
Phone: +49 (0) 231/7 55-3297, email: W.Leininger@wiso.uni-dortmund.de

Prof. Dr. Volker Clausen

University of Duisburg-Essen, Department of Economics
International Economics
Phone: +49 (0) 201/1 83-3655, e-mail: vclausen@vwl.uni-due.de

Prof. Dr. Christoph M. Schmidt

RWI, Phone: +49 (0) 201/81 49-227, e-mail: christoph.schmidt@rwi-essen.de

Editorial Office

Sabine Weiler

RWI, Phone: +49 (0) 201/81 49-213, e-mail: sabine.weiler@rwi-essen.de

Ruhr Economic Papers #475

Responsible Editor: Thomas K. Bauer

All rights reserved. Bochum, Dortmund, Duisburg, Essen, Germany, 2014

ISSN 1864-4872 (online) – ISBN 978-3-86788-537-9

The working papers published in the Series constitute work in progress circulated to stimulate discussion and critical comments. Views expressed represent exclusively the authors' own opinions and do not necessarily reflect those of the editors.

Ruhr Economic Papers #475

Magdalena A. Stroka

Drug Oversupply in Nursing Homes
An Empirical Evaluation of Administrative Data

RUHR
UNIVERSITÄT
BOCHUM **RUB**

 **RWI**

Bibliografische Informationen der Deutschen Nationalbibliothek

Die Deutsche Bibliothek verzeichnet diese Publikation in der deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über:
<http://dnb.d-nb.de> abrufbar.

<http://dx.doi.org/10.4419/86788537>

ISSN 1864-4872 (online)

ISBN 978-3-86788-537-9

Magdalena A. Stroka¹

Drug Oversupply in Nursing Homes

An Empirical Evaluation of Administrative Data

Abstract

A widely discussed shortcoming of long-term care in nursing homes for elderly is the inappropriate or suboptimal drug utilization, in particular the utilization of psychotropic drugs. This paper estimates the effect of institutionalization on the drug intake of frail elderly using administrative data from the largest sickness fund in Germany. Difference-in-differences propensity score matching techniques are used to compare drug prescriptions of frail elderly who entered a nursing home with those who remained in the out-patient care system. The findings suggest that nursing home inhabitants receive more doses of antipsychotics, antidepressants and analgesics. The potential oversupply goes along with estimated drug costs of about € 87 million per year.

JEL Classification: I10

Keywords: Medication errors; patient safety; expenditures; drug over- and undersupply; medical costs

February 2014

¹ RUB, RWI, WINEG - Scientific Institute of TK for Benefit and Efficiency in Health Care. - Helpful comments by Thomas Bauer, Hendrik Schmitz, and participants of the Annual Meeting of the dggö (Bayreuth) are gratefully acknowledged. I am grateful to my colleagues from the WINEG for the access to the data of the Techniker Krankenkasse and to the German Research Foundation (DFG) for the financial support. - All correspondence to: Magdalena A. Stroka, RUB, Universitätsstr. 150, 44801 Bochum, Germany, e-mail: Magdalena.Stroka@rub.de

1 Introduction and Literature Review

The rapidly ageing population is creating a number of challenges for both developed and developing countries. In Germany, the number of people in need of long-term care increased between 1999 and 2009 from 2.0 million to 2.3 million (Statistisches Bundesamt, 2011). At the same time, the institutionalization of care gains importance. The increasing importance of independent living arrangements, resulting in smaller household sizes, as well as an increasing female labour force participation are among others responsible for the rising demand for in-patient care. In Germany, the number of frail elderly living in nursing homes increased from 1999 till 2009 by about 11%. While in 1999 28% of all people in need of care were living in nursing homes, this number raised to 31% in 2009 (Statistisches Bundesamt, 2011).

A challenging aspect of this development is the quality of care in nursing homes, as providers of in-patient long-term care might allow for high doses of sedative medications and other psychotropic substances to reduce the workload of the nurses and increase the profits by employing as few nurses as possible (see e.g. Dowideit, 2012; Waxman, Klein, and Carner, 1985).¹ In such cases, the administered medicine may be considered as a chemical restraint or chemical violence being equivalent to being tied to the bed (Park and Tang, 2007). Such medication does not only imply poor quality of provided care services, but also high costs for the payers, i.e. the insurance companies that carry the costs of the medications and necessary treatments caused by inappropriate prescriptions. Moreover, it is well known that polypharmacy and high drug doses exert detrimental effects on morbidity and mortality in elderly (see e.g. Routledge, O'Mahony, and Woodhouse, 2004; Hajjar, Cafiero, and Hanlon, 2007; Ziere et al., 2006). Hence, the prevention and recognition of drug related problems in the elderly belong to the principal challenges regarding the assurance of patient safety as well as quality of care.

Although German nursing homes are only allowed to apply psychoactive substances that were prescribed by the resident's physician, they have a relevant impact on a resident's medication by deciding on the frequency of doctor visits, selecting physicians, and

¹ Note that German nursing homes do not carry the costs for medication as they are paid by the health insurance fund or the patients themselves.

providing information on the resident's mental and physical condition.² For German physicians, serving a nursing home usually is not a lucrative business (Gross, 2011). In fact, they have an incentive to minimize time spent examining and talking with residents. Following the nursing home's medication policy arguably is an effective strategy to save time. For instance, they can reduce the length of patient consultations if they gather information on the residents' condition and (medical) needs from the nurses.

While there exists a large literature on the quality of health services provided by hospitals (see e.g. Gowrisankaran and Town, 1999; Lien, Chou, and Liu, 2008; Needleman et al., 2002; Sloan et al., 2001), there is relatively little research on the quality of nursing homes (see e.g. Grabowski et al., 2013; Mukamel et al., 2003). Nevertheless, since decades nursing homes are suspected to provide poor quality of care (see e.g. Dowideit, 2012; Fahey et al., 2003; Institute of Medicine, 1986, 2001; Werner et al., 2012). Several studies indicate a high usage of psychotropic drugs (see e.g. Avorn et al., 1992; Alanen et al., 2006; Azermai et al., 2011; Mann et al., 2009; Pittrow et al., 2003; Ruths, Straand, and Nygaard, 2001; Waxman, Klein, and Carner, 1985) as well as potentially inappropriate medication prescribing in nursing homes (see e.g. Barber et al., 2009; Beers et al., 1992; Fialová et al., 2005; Ruths, Straand, and Nygaard, 2001). Especially, there are concerns about the prescription of antipsychotics, hypnotics, and anxiolytics as these drugs are described as chemical restraints, in that they are used to sedate and subdue patients, partly to minimize staff contact and to compensate for poor staffing levels (Hughes and Lapane, 2005).

Apart from these studies indicating suboptimal prescriptions of medication as a shortcoming of the quality of care in the in-patient nursing care sector, only few studies analyse whether the problem of potential inappropriate medication is a shortcoming of nursing homes or a general problem in both the field of informal and formal care. In their descriptive comparison of prescriptions for in- and out-patients, Hach et al. (2004) alert the problem of inappropriate medication in nursing homes. According to their findings, psychotropics are prescribed in higher amounts to frail elderly living in in-patient institutions. Rothgang et al. (2008) also indicate a possible oversupply of

² An average German nursing home cooperates with 23 physicians and nurses decide in roughly 86% of all cases about the need of a medical check-up. They also choose in 72% of all cases the respective physician (Van den Bussche et al., 2009).

psycholeptics and antidementia agents in nursing homes estimating multivariate linear regression models with administrative data. Nevertheless, as the existing studies neglect the problems of selection into treatment, i.e. nursing home entry, the estimated results should be considered with caution. If, for example, only elderly with severe health problems choose to live in in-patient institutions, the relatively higher usage of medication in these institutions may be a necessity of the negative selection of patients into these institutions. Moreover, so far, no study estimated the costs of suboptimal medication in nursing homes.

The aim of this study is to analyse the provided quality of care in nursing homes comparing drug prescriptions in the in- and out-patient long-term care sector. Using claims data from the largest sickness fund in Germany potential drug oversupply in nursing homes is analysed by performing a comparison of the medication prescriptions for in-patients and out-patients controlling for their observable characteristics and diseases via matching techniques. The types of drugs analysed in this study are psychotropic drugs including antipsychotics, antidepressants, hypnotics and sedatives, anxiolytics as well as analgesics, antidementia and antiparkinson agents, all prescribed drugs, and drugs from the Priscus-list. The latter is an official register of potentially inappropriate medication for frail elderly people in Germany (Holt, Schmiedl, and Thürmann, 2010) that resembles similar international lists such as the Beers-list (Beers, 1997). The list identifies medications that pose potential risks (including harmful side effects that may be life-threatening and other adverse drug events) that outweigh potential benefits for people 65 and older. The use of such inappropriate medication is associated with a high risk of adverse health outcomes especially in the elderly living in nursing homes (Perri et al., 2005).

This study contributes to the existing literature in several ways. First, this is the first study that addresses the potential self-selection bias in the estimated effects of in-patient nursing on the extent of medication using propensity score techniques instead of linear regressions. Second, while existing studies on the drug utilization in the in- and out-patient nursing care sector rely on cross-sectional data, this study uses a panel data set, which allows us to rely on difference-in-differences propensity score matching as identification strategy. Third, the underlying data set is much larger than the data used

in previous analyses. Finally, this paper builds upon existing literature calculating the drug costs of the potential drug oversupply.

As the matching approach is applied to administrative data generated through billing processes between health care institutions and the insurance company, data reliability should be relatively high. Moreover, besides the large sample size the data is characterized by its wealth of information regarding socio-economic characteristics and health outcomes allowing the consideration of aspects that cannot be answered with data collected in interviews. The estimation results suggest a possible oversupply in nursing homes regarding antipsychotics, antidepressants and analgesics. Even though no evidence is found for more prescriptions of inappropriate drugs in nursing homes regarding the Pricus-list, the oversupply of the drugs mentioned above may also provide evidence for inappropriate medication as they can be considered as chemical restraints administered to relieve the care effort (Dowdeit, 2012; Waxman, Klein, and Carner, 1985).

The paper is structured as follows. Section 2 describes the empirical approach and explains the data used in the empirical analysis. The quality of the propensity score matching is discussed in Section 3. Section 4 shows the results and discusses several sensitivity analyses. A summary and discussion is given in Section 5.

2 Empirical Strategy and Data

2.1 Matching

The major question addressed in this paper is whether the utilization of in-patient care services has an impact on the prescriptions of certain drugs. To address the presence of selection is essential for the research question at hand as the individuals' choice to live in a nursing home may be affected by reasons that cannot be observed by the researcher and may concurrently affect the dependent variable. Such unobservables might be preferences, health shocks as well as environmental and family influences. A simple comparison of the outcomes of the compared groups (in- and out-patients) may suffer from bias due to the selection into treatment-problem (Heckman, Ichimura, and Todd, 1998). Hence, difference-in-differences matching techniques are applied in order to answer the underlying question and to account for the selection process into in-patient care services.

The basic idea behind statistical matching (Rubin, 1974) is to find individuals in the control group that closely resemble the members of the treatment group. According to Rosenbaum and Rubin (1983, 1985) it is also sufficient to focus on a balancing score instead of conditioning the matching on a whole set of variables. The propensity score, which is estimated using a binary choice model, is the most popular balancing score (Mensah, Opong, and Schmidt, 2010). It condenses the information of the observed covariates into a single index function as for treated and non-treated with the same balancing score the distribution on the covariates are the same. In order to identify valid comparable observations, the covariates included in the binary choice model have to fulfill the conditional independence assumption (CIA) entailed by matching. Conditional on the covariates, the outcome variable and the treatment indicator are assumed to be independent. In particular, in order to give the estimates a casual interpretation, it is assumed that conditional on the covariates, the outcomes of treated in the state of non-treatment are the same as the outcomes of non-treated.

This assumption can be relaxed by the difference-in-differences propensity score matching addressing the problem of possible unobservable characteristics causing biased estimates due to unobserved heterogeneity. This approach extends the conventional difference-in-differences estimator by defining outcomes conditional on the propensity score. It is implemented by subtracting differences in the outcome variables between the treatment and the control group before the treatment period from the respective differences after the treatment period to cancel out time-invariant unobservables. In this case, the counterfactual outcome of the treated is allowed to differ from the observed outcomes of the untreated, as long as their trend is the same (Heckman, Ichimura, and Todd, 1998). Hence, the strong assumption of the conventional matching estimator that all relevant variables that determine the treatment and influence the outcome variable are included in the data set and incorporated into the matching model is relaxed. As this matching estimator brings together the literature on selection on observables with the literature on unobservables, it is regarded to be superior to pure cross-sectional matching estimators (Heckman, Ichimura, and Todd, 1997). Moreover, the difference-in-differences propensity score matching is more robust than the traditional propensity score matching (Smith and Todd, 2005).

The parameter to be estimated by the matching is the average treatment effect on the treated (ATT). This parameter indicates how treated persons have fared relative to a counterfactual situation in which these individuals would have not been treated. In general, the difference-in-differences propensity score matching estimator of the ATT can be written as (Heckman, Ichimura, and Todd, 1997; Smith and Todd, 2005):

$$\widehat{ATT} = \frac{1}{n} \sum_{i \in I_1} [\Delta Y_{1i} - \sum_{j \in I_0} \omega(i, j) \cdot \Delta Y_{0j}], \quad (1)$$

where n_1 is the number of cases in the treatment group I_1 . I_0 indicates the control group observations and $\omega(i, j)$ is a matching procedure specific weight.

2.2 Data

For the estimation of the ATT this paper makes use of administrative data from the sickness fund Techniker Krankenkasse (TK) on care dependent elderly in 2007-2009. The data provides detailed and very accurate information on health service utilization as well as measures of a wide range of health outcomes. Among others, the available data include detailed information on individual characteristics as well as all ascertained diagnoses and prescribed drugs. Extensive data on these topics is essential for the given research purpose in order to compare the medication of frail elderly controlling for their health status and further observable characteristics. The advantages of utilizing administrative data for the analysis in comparison to data obtained from interviews are twofold. First, data coverage and completeness should be relatively high as the TK insures about 12% of the German population. Hence, this paper is based on a larger data set than previous studies in this field of research. Second, data reliability should be superior to survey data since most records are reported by institutions of the in-patient and out-patient medical sector, which means that the data on health outcomes is generated by experts such as physicians and is thus less liable to subjective perception that may bias outcomes in survey data. This fact also allows data generation for senile people and persons suffering from other diseases which make them not able to answer any questionnaires in a proper way. This aspect is of relevance in this paper as the analysis is restricted to high-maintenance individuals aged 65 years and older that are

assigned to any of the three care levels, which are formally assessed by the independent Medical Review Board of the Statutory Health Insurance Funds.³

2.2.1 Outcome Variables

This study analyses nine different types of prescribed drugs. The prescriptions are measured in daily defined doses (DDDs) and are identified using the Anatomical Therapeutic Chemical (ATC) classification. The considered drugs are antipsychotics (ATC: N05A), antidepressants (ATC: N06A), sedatives and hypnotics (ATC: N05C), anxiolytics, (ATC: N05B), analgesics (ATC: N02) antidementia (ATC: N06D) and antiparkinson agents (ATC: N04), drugs from the Priscus-list as well as all prescribed drugs. Each variable measures the yearly prescribed amount of DDDs of the considered drug class. Whereas the drugs from the Priscus-list are obviously inappropriate for elderly people, the other drug classes might be appropriate. However, higher amounts of prescribed psychotropic drugs (i.e. antipsychotics, antidepressants, anxiolytics as well as hypnotics and sedatives) in nursing homes might indicate the usage of these drugs as chemical restraints (see e.g. Dowdeit, 2012). Moreover, it should also be considered that the remaining drug classes might provide interesting insights into the drug prescriptions in the in- and out-patient care as it is possible that there are differences in psychotropic drug prescriptions while there are no prescription differences considering other drugs. Especially the overall medication variable may reveal whether effects on certain drugs are due to an overall higher prescription trend. Hence, in this paper it is analysed, whether there is a general over- or undersupply of drugs in nursing homes or if only inappropriate or the critically discussed psychotropic drugs are prescribed more or less often.

2.2.2 Treatment and Control Group

For the difference-in-differences propensity score matching the data set is constrained to frail elderly individuals living at their homes during the year 2007. Moreover, the data is restricted to those individuals that can be observed until the end of 2009 and that

³ In Germany, care recipients are classified into three care levels by the Medical Review Board of the Statutory Health Insurance Funds. While care level 1 goes along with nursing needs of, on average, at least 90 minutes per day, care level 2 includes, on average, at least 180 minutes of daily nursing needs. Care level 3 is the highest one and stands for, on average, over 300 minutes of daily care.

received either in-patient or out-patient care during the year 2009. Those individuals who changed the way of received care in 2008 and live in a nursing home in 2009 are considered as treated. Hence, the difference-in-differences matching is based on the individual probability of transition from out-patient to in-patient care in 2008 and living in a nursing home in 2009. Figure I provides an overview of the construction of the treatment and control groups.

Figure I about here.

As the dependent variable is measured by the sum of DDDs prescribed in a certain year, individuals that are not observed during the whole 3 years or changed from out-patient to in-patient nursing care in another year than 2008 are deleted to avoid any bias. Furthermore, observations with values above the 99th percentile – including implausibly high values – are also excluded from both the balanced and unbalanced sample to reduce problems with outliers.⁴

2.2.3 Descriptive Statistics and the Propensity Score

This section describes the conditioning variables in the sample used in the difference-in-differences propensity score matching. Table I includes descriptive statistics of the covariates for the relevant subsample of 9,276 individuals that allows to contrast the prescription outcomes of individuals who entered a nursing home in 2008 (treated) and who remained in out-patient care (controls). All pre-treatment variables in this analysis refer to the year 2007. The variables on different diseases are binary outcomes identified using the International Classification of Diseases 10 (ICD-10). The descriptive statistics show that the treated elderly tend to be older and – regarding the pre-treatment period – have more prescribed DDDs of antipsychotics and antimentia agents but less prescribed DDDs of drugs from the Priscus-list. The considered variables are not only potential correlates of the institutionalization choice, but are also likely to be related to drug utilization outcomes under study. As the identification strategy builds on the assumption that the model includes all variables that simultaneously influence the probability of institutionalization and drug intake, the choice of the conditioning variables is crucial. Since this study relies on rich administrative data, it is not limited to

⁴ However, the results are robust to not trimming the data. The respective regression results are available from the author upon request.

the inclusion of a long list of conditioning variables containing many variables measuring the health status, but can also condition on the drug intake prior to the treatment.

The wide range of personal characteristics serves as principal pieces of information for constructing balanced samples of treated and controls. The last columns of Table I present the estimated results of a logistic regression used to calculate the propensity scores. The results show that the likelihood of receiving in-patient care increases for care dependent elderly with rising age and diseases such as dementia and other mental disorders.⁵

Table I about here.

2.3 Matching Algorithms

The estimated coefficients reported on Table I are used to estimate the propensity scores that predict the probability of becoming a nursing home inhabitant. The estimated propensity scores again are used as principal vehicles to match treated to untreated individuals applying state-of-the-art matching algorithms. While in small samples the choice of the matching approach may be important (Heckman, Ichimura, and Todd, 1997), with growing sample sizes all matching approaches become closer to exact matching and should yield asymptotically the same result (Smith, 2000). The four adopted matching techniques in this study are the 5-to-1 nearest-neighbor matching⁶ with replacement, 1-to-1 nearest-neighbor matching without replacement as well as radius and kernel matching. The first method matches individuals who have switched from out-patient care to in-patient care with control individuals who display the nearest value of the propensity score. As the nearest-neighbor matching faces the risk of bad matches if the closest neighbor is far away, a tolerance on the maximum distance of the propensity scores allowed is imposed, using caliper matching. The radius matching is a variant of the caliper matching. The basic idea of this variant is to use not only the nearest-neighbor within each caliper but all of the units within the caliper. In the kernel approach treated individuals are matched with a weighted average of all controls, with

⁵ Results refer to marginal effects that are not presented in addition to the coefficients for the cause of brevity.

⁶ 5-to-1 nearest-neighbour matching assigns the five closest control group observations to any treatment group observation.

weights that are inversely proportional to the distance between treated and controls. Kernel is applied implicitly with replacement (Becker and Ichino, 2002). A caliper of width 0.01 is used in the nearest-neighbor and radius matching, and a bandwidth of also 0.01 is used in the kernel matching algorithm. The fairly strict caliper and bandwidth allow requiring a high degree of observational similarity between treatment and control cases and still find matching control cases for the treatment cases. Nevertheless, all variations of the caliper or bandwidth generate very similar results.

3 Matching Quality

It is important to check the overlap of common support region for the treated and non-treated before presenting the results. The visual analysis of the density distribution of the propensity score in both treated and non-treated is given in Figure II. The upper part of the figure displays the propensity score distribution for the treated, the lower part refers to the control group. It becomes evident that the distributions are skewed to the left. As problems arise when distributions do not overlap, the common support is implemented in the matching approach and observations, whose propensity score is smaller than the minimum and higher than the maximum in the comparison group are disregarded. Clearly, for treated individuals who fall outside the common support, the treatment effect cannot be estimated. In cases of small numbers of lost individuals only few problems arise, but if the proportion of lost individuals is large, the remaining individuals may be considered as not representative (Bryson, Dorsett, and Purdon, 2002). Figure II makes clear that the overlap between treated and non-treated is good and the number of lost individuals is fairly low with one to four observations as can be seen in the last row of Table III.

Figure II about here.

Following Rosenbaum and Rubin (1985) the quality of the matching procedure is investigated by comparing the means of the covariates of the treatment and control group. Table II shows that the matching procedure results in a good balance of both groups. All matching approaches achieve satisfactory balance in the observables as differences are insignificant in the matched samples.

Table II about here

After the propensity scores has been used to construct two equivalent groups of treated and non-treated, the ATT is measured using differences in outcomes between these two groups. They are reported in the next section.

4 Results

Table III shows the raw mean outcomes for treated and controls and the estimates of the ATT of institutionalization based on the difference-in-differences propensity score matching. The considered outcomes represent differences of the prescribed DDDs between 2009 and 2007. Again, the first two columns present the raw means, while the ATTs are presented from the third column on. The estimated results confirm previous research indicating a potential overmedication regarding certain psychotropic drugs in the in-patient nursing care sector. Frail elderly living in a nursing home display significantly higher amounts of prescribed DDDs of antipsychotics, antidepressants and analgesics. No differences can be found for hypnotics and sedatives, anxiolytics, antidementia agents, antiparkinson agents, drugs from the Pricus-list as well as all drugs together. Overall, the estimates of the institutionalization effect on drug prescriptions are very robust according to the employed econometric techniques.

Table III about here.

In order to obtain an idea of the estimation results in terms of costs from the payer's perspective, i.e. the sickness funds, a back-on-the-envelope calculation is performed for the significant results. The results are extrapolated to the entire German population in nursing homes in 2009. In the in-patient nursing care sector one DDD of antipsychotics costs on average € 4.36,⁷ thus the potential oversupply in nursing homes goes along with spendings of about € 39,791,421 a year. In case of antidepressants (€ 0.74/DDD) the estimated costs are about € 12,678,909 and the potential oversupply of analgesics (€ 2.00/DDD) goes along with spendings of about € 34,855,664.⁸ Note, however, that these amounts comprise only the direct spendings for the considered drugs. Further cost aspects like treatment expenses, consultation costs or costs caused by adverse drug

⁷ This information (as well as the other information on prices for DDDs of certain drugs) is obtained from the underlying data set for the year 2009.

⁸ Calculations: antipsychotics: € 4.36/DDD * 717,490 dependent persons in nursing homes * 12.72 effect from NN with Repl.; antidepressants: € 0.74/DDD * 717,490 dependent persons in nursing homes * 23.88 effect from NN with Repl.; analgesics: € 2.00/DDD * 717,490 dependent persons in nursing homes * 24.29 effect from NN with Repl.

effects etc. are not considered. As the number of frail elderly is expected to increase in the future, the direct costs will also increase given that the potential oversupply will continue to exist.

As mentioned above, the estimation of treatment effects with matching estimators is based on the CIA. Thus, if the treated and non-treated differ in unobserved characteristics, there may be a bias against which the matching estimator is not robust. Even though the difference-in-differences propensity score matching eliminates any time invariant differences between the treatment and control group and thus allows for selection on both observed as well unobserved characteristics that are constant over time, the problem of time varying unobservables remains. This potential problem is addressed with the bounding approach proposed by Rosenbaum (2002). This approach calculates upper and lower bounds on the test-statistics used to test the hypothesis of no institutionalization effect for different values of hidden bias, i.e. it determines how strongly an unobserved variable must influence the selection process in order to undermine the implications of the matching analysis.

Table IV presents the bounding results for the difference-in-differences propensity score giving the outcome of the p-values from the Wilcoxon sign-rank test for the average treatment effect on the treated, while setting the level of hidden bias to a certain value Γ . The parameter Γ reflects the assumption about hidden bias in treatment assignment. At each Γ a hypothetical significance level is calculated, which represents the bound on the significance level of the treatment effect in case of hidden bias. By comparing the Rosenbaum bounds on treatment effects at certain levels of Γ it is possible to assess the strength, the unmeasured heterogeneity or endogeneity would require so that the obtained effects from the matching analysis would have arisen solely through selection effects. Table V shows that the robustness to hidden bias varies considerably across the outcome variables. In case of antipsychotics, the statistics imply that at $\Gamma=1.15$ the treatment effect is no longer statistically significant at $p=0.05$. For antidepressants this is the case at $\Gamma=1.25$ and for analgesics at $\Gamma=1.30$. The large values of Γ considering antidepressants and analgesics suggest that, having matched on observed covariates, the unobserved confounding variable would have to increase the likelihood of treatment by around 25% in case of antidepressants and by around 30% in case of analgesics.

Table IV about here.

The hypothetical hidden bias may directly result from an impairment of the health status. Even though we compare treated and untreated individuals that have similar probabilities to enter a nursing home in 2008 based on their characteristics and health outcomes in 2007 using propensity score matching approaches, the health outcomes may change rapidly and the treated may suffer from a greater health impairment causing their entrance in a nursing home. To analyse whether institutionalized elderly suffer from greater health impairment than non-institutionalized, we compare health outcomes of these two groups using again the difference-in-differences propensity score matching. In this analysis the treatment is the same as in the main analysis in this paper, namely the institutionalization of out-patient frail elderly in 2008. The considered outcome variables are the disease outcomes. Table V documents the estimated ATT.

Table V about here.

A robust and significant result indicating a health related impairment between 2007 and 2009 in case of institutionalized elderly can be observed solely in case of dementia. All other diseases indicate no impairment or even a health improvement for elderly, who decided to move into a nursing home. Thus, the higher amounts of prescribed DDDs of antipsychotics, antidepressants and analgesics are most likely not caused by health impairments of institutionalized frail elderly but indicate a potential overmedication with these drugs in nursing homes.

5 Discussion

This paper examines the effect of institutionalization of the elderly on prescriptions of various drug categories using administrative records from one of Germany's largest sickness funds. Difference-in-differences propensity score matching approaches are used to empirically compare the prescriptions of the DDDs of institutionalized frail elderly and those who remained in out-patient care, taking observable covariate differences into account. This method as well as the underlying data has not been used in this field of research so far. As the propensity score matching removes most of the bias attributable to observables, the differences in mean outcomes in the matched sample can be used to obtain an estimate of the ATT. In order to check the robustness of the results from the nearest-neighbor, kernel and radius matching is applied as well. The empirical results are robust to the applied econometric methods. Moreover, the

sensitivity analysis using Rosenbaum bounds shows that the obtained results for antidepressants and analgesics are robust to theoretically possible hidden bias.

Even though a range of variables on the individual's health is controlled for, an impairment of the health status in the considered period may influence the choice of entering a nursing home, since the question of health developments remains delicate. As I am not able to control for health impairments, I analyse whether certain health outcomes changed between treated and controls using propensity score matching techniques. This analysis reveals that treated people are significantly more often demented. Nevertheless, no indications for higher prescriptions of antimentia agents for in-patients are observed in the comparison of drug prescriptions. Instead, evidence is found for higher prescribed amounts of DDDs of antipsychotics, antidepressants and analgesics for institutionalized elderly. As a range of observable characteristics and the health status are controlled for in the analysis, these higher amounts can be considered as evidence for a potential oversupply of these drugs in nursing homes, which may be caused by the adoption of these drugs as chemical restraints in order to relieve the care effort of the nursing staff. The yearly costs of this potential oversupply are estimated to reach almost € 87 million. However, the estimated costs include only the direct spendings for the drugs. In a complete analysis one should also account for consultation and treatment costs as well as further costs caused by adverse effects of the drugs. The possible impairment of the individual quality of life should be also taken into account. Thus, the real costs are expected to be much higher.

Certainly, this analysis provides only a first empirical hint towards the widely discussed suspicion of a psychotropic drug oversupply in nursing homes as the given question is considered solely from a quantitative point of view and many qualitative aspects remain unconsidered. Since it is difficult to define appropriate amounts of drugs for certain individuals, the higher prescriptions in nursing homes can only be supposed to describe a drug oversupply, as one could also consider these results to provide evidence for an undersupply in the out-patient care sector. However, given the large literature on inappropriate medication in nursing homes that is discussed above, the latter interpretation can be considered as less reasonable. In any case, action is required from all concerns.

Figures

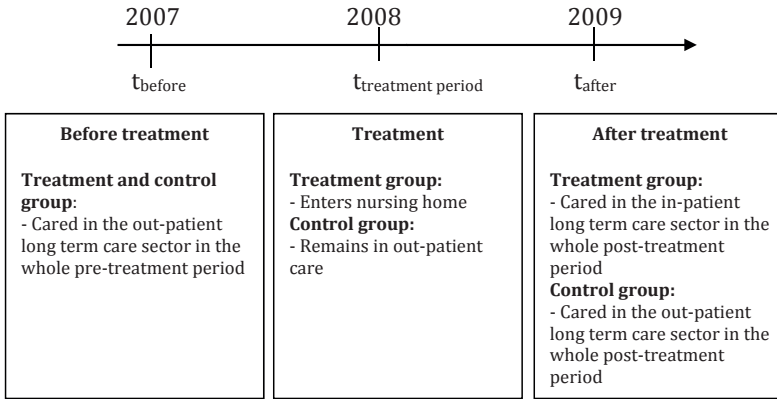


Figure I: Construction of the treatment and control group

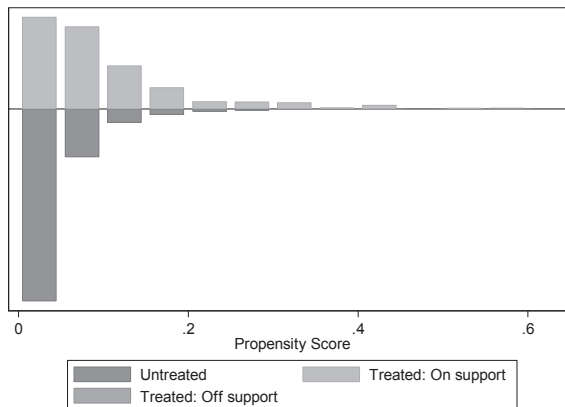


Figure II: Density Distribution of the Propensity Score

Tables

Table I: Covariates – Descriptive Statistics and the Propensity Score

Variable	Means		Difference	Propensity Score	
	Treated	Controls	t-values	Coef.	Std. E.
Individual characteristics					
Female	0.64	0.50	5.80***	0.331***	(0.118)
Age	83.28	78.33	12.48***	0.068***	(0.007)
Pre-treatment care dependency					
Care Level 2	0.36	0.34	1.16	0.015	(0.112)
Care Level 3	0.05	0.08	-2.29**	-	(0.243)
				0.780***	
Pre-treatment health status					
Depression and bipolar disorder	0.34	0.31	0.99	-0.046	(0.121)
Schizophrenia, schizotypal and delusional disorders	0.05	0.03	1.82*	-0.118	(0.266)
Dementia	0.50	0.21	13.88***	0.907***	(0.116)
Mental disorders due to psychoactive substance use	0.03	0.06	-1.98**	-0.409	(0.286)
Other mental disorders	0.10	0.03	9.71***	1.086***	(0.190)
Stroke	0.28	0.33	-2.35**	0.092	(0.121)
Cardiac infarction	0.06	0.07	-0.72	-0.003	(0.213)
Other diseases of the circulatory system	0.11	0.93	0.18	-0.180	(0.210)
Invasive neoplasms	0.20	0.23	-1.14	-0.079	(0.129)
Diseases of the musculoskeletal system	0.74	0.73	0.53	-0.048	(0.124)
Diseases of the genitourinary system	0.54	0.59	-2.39**	-0.200*	(0.110)
Parkinson's disease	0.18	0.14	2.31**	0.164	(0.143)
Injuries and poisoning	2.34	2.04	1.61	0.017	(0.014)
Number of consultations	49.88	48.81	-2.34**	-0.003	(0.002)
Number of hospitalizations	1.00	0.78	3.27***	-	(0.030)
				0.107***	
Pre-treatment medication [DDDs per year]					
Antipsychotics	31.82	10.52	4.94***	0.003***	(0.001)
Antidepressants	101.79	70.81	1.63	0.000	(0.000)
Hypnotics and Sedatives	19.32	13.49	0.80	0.001	(0.001)
Anxiolytics	9.47	9.07	0.22	0.000	(0.001)
Analgetics	84.33	65.47	-0.34	0.000	(0.000)
Antidementia agents	50.37	23.67	8.03***	0.001***	(0.000)
Antiparkinson agents	1.71	1.06	-0.75	-0.005	(0.006)
Priscus-list	72.03	86.07	-1.88*	-0.001	(0.000)
All drugs	1930.14	2054.06	-2.34**	-0.000	(0.000)
Observations	425	8,663			

Notes: Significant at ***: 1% level; **: 5% level; *: 10% level; Pseudo R-squared = 0.1090.

Table II: Covariate Balance - Individual t-Test

Variable	Unmatched Difference	NN with Repl. ¹⁾	NN without Repl. ¹⁾	Radius ¹⁾	Kernel ²⁾
Individual characteristics					
Female	5.80***	-0.27	-0.14	-0.16	-0.18
Age	12.48***	-0.78	0.24	-0.41	-0.55
Pre-treatment care dependency					
Care Level 2	1.16	-0.30	-1.07	-0.18	-0.18
Care Level 3	-2.29**	0.26	0.49	-0.19	-0.26
Pre-treatment health status					
Depression and bipolar disorder	0.99	0.05	-0.15	0.15	0.10
Schizophrenia, schizotypal and delusional disorders	1.82*	1.01	0.17	0.44	0.45
Dementia	13.88***	0.46	0.07	0.36	0.32
Mental disorders due to psychoactive substance use	-1.98**	-0.41	-0.37	0.13	0.11
Other mental disorders	9.71***	0.32	0.12	0.37	0.41
Stroke	-2.35**	0.22	-0.53	0.15	0.12
Cardiac infarction	-0.72	-0.03	-0.14	0.22	0.25
Other diseases of the circulatory system	0.18	-0.61	-0.70	-0.23	-0.23
Invasive neoplasms	-1.14	-0.06	-0.34	0.10	0.15
Diseases of the musculoskeletal system	0.53	-0.08	0.24	-0.04	0.00
Diseases of the genitourinary system	-2.39**	0.17	-0.62	0.01	0.03
Parkinson's disease	2.31**	-0.45	-0.35	-0.19	-0.21
Injuries and poisoning	1.61	0.04	0.49	0.17	0.18
Number of consultations	-2.34**	-0.25	-0.11	0.05	0.09
Number of hospitalizations	3.27***	0.42	-0.02	0.64	0.63
Pre-treatment medication					
Antipsychotics	4.94***	0.35	-0.40	0.21	0.17
Antidepressants	1.63	-0.15	0.28	0.16	0.20
Hypnotics and Sedatives	0.80	-0.37	0.82	-0.13	-0.16
Anxiolytics	0.22	-0.30	-0.09	-0.14	-0.14
Analgetics	-0.34	-0.31	1.12	-0.12	-0.14
Antidementia agents	8.03***	0.22	-0.43	-0.10	-0.17
Antiparkinson agents	-0.75	-0.22	1.71	-0.04	-0.07
Priscus-list	-1.88*	-0.17	1.26	0.09	0.07
All drugs	-2.34**	-0.30	0.34	-0.14	-0.13

Notes: Significant at ***: 1% level; **: 5% level; *: 10% level. Baseline categories: "Care level: 3". —¹⁾Imposed caliper width: 0.01. ". —²⁾Imposed bandwidth: 0.01.

Table III: Treatment Effects of Institutionalization on Drug Prescriptions (Preferred Model)

Variable	Means		ATT (t-values)			
	Treated	Controls	NN with Repl. ¹⁾	NN without Repl. ¹⁾	Radius ¹⁾	Kernel ²⁾
Antipsychotics	11.64	1.09	12.72*** (3.88)	12.46*** (3.42)	12.20*** (3.87)	12.31*** (3.90)
Antidepressants	20.47	2.39	23.88*** (2.71)	23.10** (2.25)	24.60*** (2.90)	24.42*** (2.88)
Hypnotics and Sedatives	3.49	0.25	2.93 (0.63)	0.35 (0.07)	3.23 (0.71)	3.30 (0.73)
Anxiolytics	0.44	0.49	-0.37 (-0.17)	0.23 (0.09)	0.16 (0.08)	0.19 (0.09)
Analgetics	27.48	6.16	24.29*** (3.48)	26.08** (3.34)	23.01*** (3.45)	23.25*** (3.48)
Antidementia agents	-8.82	1.62	-7.36 (-1.08)	-9.58 (-1.18)	-5.80 (-0.89)	-5.77 (-0.89)
Antiparkinson agents	1.21	0.05	1.13 (1.27)	0.30 (0.26)	0.97 (1.14)	0.99 (1.16)
Priscus-list	-5.44	-7.24	1.20 (0.16)	-0.71 (-0.09)	0.81 (0.11)	0.82 (0.12)
All drugs	104.87	75.62	57.70 (1.04)	71.92 (1.14)	58.24 (1.09)	59.04 (1.11)
Treated	425	8,663	424	421	424	424

Notes: Significant at ***: 1% level; **: 5% level; *: 10% level. T-values in parentheses. Baseline categories: "Care level: 3". -¹⁾ Imposed caliper width: 0.01. ". -²⁾ Imposed bandwidth: 0.01.

Table IV: Rosenbaum Bounds

Variable	P-Critical at Γ :							
	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35
Antipsychotics	0.004	0.012	0.033	0.074	0.141	0.235	0.355	0.477
Antidepressants	<0.001	0.001	0.004	0.012	0.029	0.062	0.116	0.193
Analgetics	<0.001	<0.001	0.002	0.005	0.015	0.034	0.070	0.126

Notes: Results for NN w/ Repl. p-critical is p+

Table V: Treatment Effects of Institutionalization on Health Impairment

Variable	Effects			
	NN with Repl. ¹⁾	NN without Repl. ¹⁾	Radius ¹⁾	Kernel ²⁾
Depression and bipolar disorder	-0.027	-0.017	-0.006	-0.005
Schizophrenia, schizotypal and delusional disorders	0.012	0.010	0.015	0.015
Dementia	0.150***	0.114***	0.166***	0.165***
Mental disorders due to psychoactive substance use	0.002	0.012	0.004	0.005
Other mental disorders	0.009	0.017	0.007	0.007
Stroke	0.034	0.048	0.018	0.017
Cardiac infarction	0.000	-0.017	0.008	0.008
Other diseases of the circulatory system	-0.018	-0.014	-0.015	-0.015
Invasive neoplasms	-0.079***	-0.060**	-0.072***	-0.071***
Diseases of the musculoskeletal system	-0.087***	-0.105***	-0.078**	-0.078**
Diseases of the genitourinary system	0.027	0.024	0.036	0.037
Parkinson's disease	0.031	0.033	0.022	0.023

Notes: Significant at ***, 1% level; **, 5% level; *, 10% level. Baseline categories: "Care level: 3". - ¹⁾Imposed caliper width: 0.01. - ²⁾Imposed bandwidth: 0.01.

References

- Alanen H., Finne-Soveri H., Noro A., Leinonen E. 2006. Use of antipsychotic medications among elderly residents in long-term institutional care: a three-year follow-up. *International Journal of Geriatric Psychiatry* **21**: 288–295.
- Avorn J., Soumerai S. B., Everitt D. E., Ross-Degnan D., Beers M. H., Sherman D., Salem-Schatz S. R., Fields D. 1992. A randomized trial of a program to reduce the use of psychoactive drugs in nursing homes. *The New England Journal of Medicine* **327**: 168–173.
- Azermai M., Elseviers M., Petrovic M., van Bortel L., Stichele R. V. 2011. Geriatric drug utilisation of psychotropics in Belgian nursing homes. *Human Psychopharmacology: Clinical and Experimental* **26**: 12–20.
- Barber N. D., Alldred D. P., Raynor D. K., Dickinson R., Garfield S., Jesson B., Lim R. et al. 2009. Care homes' use of medicines study: prevalence, causes and potential harm of medication errors in care homes for older people. *Quality and Safety in Health Care* **18**: 341–346.
- Becker S. O., Ichino A. 2002. Estimation of average treatment effects based on propensity scores. *Stata Journal* **2**: 358–377.
- Beers M. H., Ouslander J. G., Fingold S. F., Morgenstern H., Reuben D. B., Rogers W., Zeffren M. J., Beck J. C. 1992. Inappropriate medication prescribing in skilled-nursing facilities. *Annals of Internal Medicine* **117**: 684–689.
- Bryson A., Dorsett R., Purdon S. 2002. *The use of propensity score matching in the evaluation of active labour market policies*. London: Dept. of Work and Pensions.
- Fahey T., Montgomery A. A., Barnes J., Protheroe J. 2003. Quality of care for elderly residents in nursing homes and elderly people living at home: controlled observational study. *British Medical Journal* **326**: 580.
- Fialová D., Topinková E., Gambassi G., Finne-Soveri H., Jónsson P. V., Carpenter I., Schroll M. et al. 2005. Potentially inappropriate medication use among elderly home care patients in Europe. *JAMA: The Journal of the American Medical Association* **293**: 1348–1358.
- Gowrisankaran G., Town R. J. 1999. Estimating the quality of care in hospitals using instrumental variables. *Journal of Health Economics* **18**: 747–767.
- Grabowski D. C., Feng Z., Hirth R., Rahman M., Mor V. 2013. Effect of nursing home ownership on the quality of post-acute care: An instrumental variables approach. *Journal of Health Economics* **32**: 12–21.
- Hach I., Rentsch A., Krappweis J., Kirch W. 2004. Psychopharmakaverordnungen an älteren Menschen: Ein Vergleich zwischen Patienten aus Alten- und Pflegeheimen, ambulant behandelten Pflegefällen und ambulanten Patienten ohne Pflegebedarf. *Zeitschrift für Gerontologie und Geriatrie* **37**: 214–220.

- Heckman J. J., Ichimura H., Todd P. 1998. Matching As An Econometric Evaluation Estimator. *The Review of Economic Studies* **65**: 261–294.
- Heckman J. J., Ichimura H., Todd P. E. 1997. Matching as an econometric evaluation estimator: Evidence from evaluating a job training programme. *The Review of Economic Studies* **64**: 605–654.
- Holt S., Schmiedl S., Thürmann P. A. 2010. Potenziell inadäquate Medikation für ältere Menschen: Die PRISCUS-Liste. *Deutsches Ärzteblatt* **107**: 543–551.
- Hughes C. M., Lapane K. L. 2005. Administrative initiatives for reducing inappropriate prescribing of psychotropic drugs in Nursing Homes: How successful have they been? *Drugs & Aging* **22**: 339–351.
- Lien H. M., Chou S. Y., Liu J. T. 2008. Hospital ownership and performance: evidence from stroke and cardiac treatment in Taiwan. *Journal of Health Economics* **27**: 1208–1223.
- Mann E., Kopke S., Haastert B., Pitkala K., Meyer G. 2009. Psychotropic medication use among nursing home residents in Austria: a cross-sectional study. *BMC Geriatrics* **9**: 18.
- Mensah J., Oppong J. R., Schmidt C. M. 2010. Ghana's national health insurance scheme in the context of the Health MDGs - An empirical evaluation using Propensity Score Matching. *Health Economics* **19**: 95–106.
- Mukamel D. B., Spector, W. D. 2003. Quality report cards and nursing home quality. *The Gerontologist* **43**: 58–66.
- Needleman J., Buerhaus P., Mattke S., Stewart M., Zelevinsky K. 2002. Nurse-staffing levels and the quality of care in hospitals. *The New England Journal of Medicine* **346**: 1715–1722.
- Pittrow D., Krappweis J., Rentsch A., Schindler C., Hach I., Bramlage P., Kirch W. 2003. Pattern of prescriptions issued by nursing home-based physicians versus office-based physicians for frail elderly patients in German nursing homes. *Pharmacoepidemiology and Drug Safety* **12**: 595–599.
- Rosenbaum P. R., Rubin D. B. 1983. The central role of the Propensity Score in observational studies for causal effects. *Biometrika* **70**: 41–55.
- Rosenbaum P. R., Rubin D. B. 1985. Constructing a control group using multivariate matched sampling methods that incorporate the Propensity Score. *The American Statistician* **39**: 33–38.
- Rosenbaum P. R. 2002. *Observational Studies*. New York: Springer.
- Rothgang H., Brochert L., Müller R., Unger R. 2008. *GEK-Pflegereport 2008: Schwerpunktthema: Medizinische Versorgung in Pflegeheimen*. Sankt Augustin: Asgard. Available at: <http://www.worldcat.org/oclc/552556038>.
- Rubin D. B. 1974. Estimating casual effects of the treatment in randomised and non-randomised studies. *Journal of Educational Psychology* **66**: 688–701.

- Ruths S., Straand J., Nygaard H. A. 2001. Psychotropic drug Use in nursing homes - Diagnostic indications and variations between institutions. *European Journal of Clinical Pharmacology* **57**: 523–528.
- Sloan F. A., Picone G. A., Taylor D. H., Chou S. Y. 2001. Hospital ownership and cost and quality of care: is there a dime's worth of difference? *Journal of Health Economics* **20**: 1–21.
- Smith J. A. 2000. A critical survey of empirical methods for evaluating active labor market policies. *Schweizerische Zeitschrift für Volkswirtschaft und Statistik* **136**: 1–22.
- Smith J. A., Todd P. E. 2005. Does matching overcome LaLonde's critique of nonexperimental estimators? Experimental and non-experimental evaluation of economic policy and models. *Journal of Econometrics* **125**: 305–353.
- Statistisches Bundesamt. 2011. *Pflegestatistik 2009: Pflege im Rahmen der Pflegeversicherung; Deutschlandergebnisse*. Wiesbaden: Statistisches Bundesamt.
- Werner R. M., Norton E. C., Konetzka R. T., Polsky D. 2012. Do consumers respond to publicly reported quality information? Evidence from nursing homes. *Journal of Health Economics* **31**: 50–61.