GPs as citizens agents: prescription behaviour and altruism

Andreas Boegh[1], Dorte Gyrd-Hansen[1,2], Sofie Hartung Hansen[1], Kim Rose Olsen[1*]

[1]*DSI Danish Institute for Health Services Research*

[2] *Copenhagen Business School*

** Corresponding author*

Dampfærgevej 27-29

DK-2100 Copenhagen Ø

Tel: +4535298429, Fax: +4535298499, @: kro@dsi.dk

ABSTRACT

To curb the heavily increasing drug budgets some Danish counties have recently introduced voluntary agreements between General Practitioners (GPs) and the health authorities as a regulatory mechanism. These agreements have a strong emphasis on increasing the GPs motivation to act as citizens' agents and are followed up by prescription guidelines that advocate both generic and analogue substitution.

In this paper we extend the models of generic prescription by Hellerstein (1998) and Lundin (2000) to allow for analogue substitution and present an empirical model based on differences in differences in the price of drugs before and after implementation of the voluntary agreement.

For two drug groups (lipid lowering drugs and drugs for rheumatism) we find evidence of a significant reduction in the costs associated with the prescription behaviour of the GPs from the intervention county. The intervention is found to have a larger impact on the prescription behaviour of GPs with low loyalty to the insurer, with low prescription quality and amongst GPs in solo practices. Earlier studies of interventions aimed at changing the prescription behaviour of Danish GPs have shown no significant effect. We conclude that the effectiveness of the voluntary approach

may partly be due to the indirect effect on the GPs altruistic motivation, which makes the GPs and the authorities collude in a common agency role.

Introduction

Drug expenditures are increasing at an incredible speed and threaten the sustainability of health care budgets. In Denmark pharmacies are allowed to hand out the cheapest generic substitute, but GPs have the opportunity to deny generic prescription. Patients preferences for trademark drugs and the threat of lower compliance if generic substitution takes place may thus affect prescription behaviour. There is however a huge potential for reducing drug expenditures if GPs take a societal (cost) perspective into consideration when deciding which analogue drug to prescribe. The problem with GPs taking the role as societal agents is the dual agency role that this would imply. The explicit role as patients' agents and the implicit role as societal agents might leave them with dilemmas that are difficult to solve in the daily decision making situations (Coast 2001).

Various methods are being used to induce GPs to take a societal perspective in their treatment strategies. As prescription costs constitute a large share of the GP budgets interventions frequently target GPs prescription behaviour. These range from soft regulation such as eg audits and pharmacist visits, over fundholding schemes, and to hard regulation consisting of economic sanctions and fines.

Soft regulation

Many countries use national guidelines, encouragement of generic prescription, audits and pharmacist visits to try to influence GPs prescription behaviour. These interventions are most often regarded as educational services or as interventions sought to balance the marketing efforts by the

pharmaco industry. The effect of these kinds of interventions is difficult to measure and the evidence in the literature is mixed. A Danish experiment with prescription feedback to GPs turned out ineffective. The GPs did not alter their prescription behaviour, and they perceived the feedback as a violation of their autonomy. In addition, the GPs found that the feedback provided little information as to how exactly they should change their behaviour (Søndergaard et al. 2002). There is however examples of successful soft regulation. Rodgers et al. (1999) show that visits by a pharmacist based on a voluntary scheme was effective; the prescription costs increased less in practises with a pharmacist employed compared to practices without a pharmacist employed. Taking into account the increase in employment costs and the start-up costs of the scheme, the authors conclude that the costs of the scheme are offset by savings in prescriptions costs. Also, Roberts et al., 1997 show that encouragement of generic prescription in Northern Ireland was effective in cutting costs.

Budgets and fundholding

England, Germany and Sweden have all experimented with fundholding schemes. The effectiveness of such regulation is mixed. Fundholding was introduced in England in 1992 and abolished in 1998. Each practise could choose to receive a budget to pay the costs of certain types of elective surgery for their patients. If the budget was not used fully, the GP could use any remaining surplus to buy additional services from themselves to provide care to their patients. Thus, they had an incentive to cut referral rates as they could benefit financially by doing so. The abolition of the system increased ex-fundholders' admission rates to secondary care, and when the system was discontinued, costs increased compared to former non-fundholders' practices (Dusheiko et al. 2006)

Germany introduced an overall expenditure cap for ambulatory physicians' pharmaceutical prescribing cost. Initially, the program lead to fewer prescriptions. The physicians were held

financially responsible for the deficit, but refused to pay. The effects of the intervention seemed to vanish in the long run (Delneij & Brenner 2000). It is not clear whether the program had adverse effects on the allocation of resources, i.e. if it caused under-provision of resources to certain groups in the population (Busse, Schreyogg, & Henke 2005).

Some Swedish municipalities have introduced 'hard' budget constraints for their health care centres. That is, a fixed budget for pharmaceuticals, giving each centre an incentive to cut costs as they are allowed to keep any surplus. Compared to centres with open-ended budgets, no significant reduction in pharmaceutical costs was registered (Granlund, Rudholm, & Wikström 2006).

Sanctions and fines

At the end of the scale some interventions have used sanction and fines to try to affect GPs prescription behaviour. In the 1990s France introduced a system where GPs had to adhere to certain prescription rules, or risk being fined. The scheme led to a reduction in the growth of costs for services outside hospitals, yet it is uncertain whether the surveillance costs outnumbered the savings. Also, the impact on the patients' health has not been evaluated (Dixon 1997).

The Danish intervention

A novel regulatory mechanism has recently been introduced in some Danish counties which combines soft regulations (audits, pharmacist visits and guidelines) with a carefully negotiated voluntary agreement between the principal (the health authority) and the agent (the GP). The agreement was signed by the County and the chairman of the local association of general practitioners. The parties behind the agreement used the negotiation process to agree that action was indeed necessary and that the only way forward was collaboration and recognition that the health

care budget is a null sum game: overuse in prescription drugs necessarily leads to less treatment elsewhere in the system. The agreement which was set up as a written contract consists of four paragraphs. The first paragraph refers to the citizen agent relationship that the GP faces by referring to an already existing agreement between the national association of GPs and the National Health Service which states that a GP is obliged to assist the National Health Service in accomplishing economically justifiable health care. It is further stated that the parties of the contract agree on the necessity of trying to take action on the heavy increases in drug expenditures. It is explicitly stated that this should be accomplished by

1. Trying to influence the GPs prescription behaviour in a more economically favourable way and
2. To supply the GP with information on his/her own prescription pattern and counselling on how to accomplish a more economically favourable prescription behaviour.

Clearly this first paragraph has a strong focus on economics. The second paragraph simply states that GPs are thought to be the target group of the agreement but that prescription behaviour in hospitals should be subject to similar intervention. This statement was crucial for the acceptance of the agreement, as hospital prescription behaviour affects the GPs potential for curbing costs. The pharmaco industry may dump prices when selling to hospitals knowing that once a patient is familiar with a specific drug, the patient may pressure the GP to continue prescription despite the high cost of the drug. By insisting on interventions at the hospital level the GPs are focusing on affecting prescription behaviour in other areas of the health care system, in order to optimise the overall impact of the intervention. This element of the contract can be considered as one of the most important differences between the voluntary agreement approach and the more direct regulatory mechanism used in other countries. It links various aspects of the health care budget and

acknowledges that the health care budget can only be reduced when taking a holistic perspective. The so-called budget silo mentality which is often argued as being a main obstacle for cost containment is hereby avoided (Drummond & Jönsson 2003).

The third paragraph describes the intervention that the county applies in trying to meet the objectives stated in paragraph one. These are: audits, encouraging increases use of generic substitution, development of guidelines for choosing analogue drugs based upon evidence and costs, follow-up information for GPs with large variation in prescription pattern.
The guidelines recommend specific analogue drugs as first choice. For Lipid Lowering drugs the recommendation is first of all to encourage the patient to change smoking-, diet- and physical activity habits. If this does not show any effect after 3-5 months simvastatin is recommended as a first choice. For rheumatism the recommendation is that COX II inhibitors should never be first choice.

The final paragraph states that the agreement should be subject to an evaluation after 1½ year. This evaluation has taken place and was carried out by the county itself (Sundhedsforvaltningen 2005). The evaluation was based on graphical exploration of prices and saving potentials and no statistical tests were performed.

The model

The voluntary agreement (VA) defines a prescription algorithm which incur a price of p_i in situation i. For various reasons the GP might ex ante have a prescription behaviour which implies a price p*_i in situation i. Hellerstein (1998) and Lundin (2000) model the decision to prescribe generic drugs (Hellerstein 1998;Lundin 2000). In their model the physicians' decision of whether or

not to prescribe the generic drug is a function of the price difference between the trademark drug and the generic, the degree of loyalty to the patient and the insurer as well as to the brand. Our scenario is different since we are operating with analogue substitution which does not guarantee an identical profile of the effects of the drug, i.e. health outcomes and potential adverse effects. In order to take this factor into account we need to extend the model to encompass the patient's perception of the effect of substitution as well as the GPs perception of potential health implications. As there is no punishment in the VA the only way the VA intervention can change the physicians' behaviour is by supplying information that is sufficiently convincing for him to change – or by inducing altruistic incentives such that his loyalty to the insurer increases. Because the physician acts as an agent for the patient we also need to take the patients preferences into account. The following model extends the models on generic prescription by Hellerstein (1998) and Lundin (2000) in three ways

+ We assume that the patients' demand for the drugs recommended in the VA is a function of a cost benefit calculation of out-of-pocket payment savings and perceived health effects
+ We assume that the GPs decision of whether or not to follow the VA is based on a cost benefit calculation of cost savings and health effects
+ Where Hellerstein and Lundin operated with data at a more detailed level, i.e. at prescription level, we operate with a more aggregated data set. We base our estimations on prescription behaviour at GP level and focus on the differences in the average cost per daily defined dosis before and after the VA intervention.

Patients demand

As Blomqvist (1991) we assume that the patient's utility function is an additive and separable function of health status, *z*, and consumption, *c*. Patients utility is given by

$$U = u(c) + h(z) \tag{1}$$

For simplicity we assume that consumption is defined as income minus drug expenditures and that

$$u(c) = y - \theta p \tag{2}$$

where θ is the amount of the drug expenditures that is covered by the patient and the share $(1-\theta)$ is paid by the insurer. Patients demand for drugs depends on his expected utility $E[U]$ from the treatment regime. Because of imperfect information the patient does not know the true health effect of a treatment regime hence

$$E[U] = y - \theta p + E[h(z)] \tag{3}$$

Define by subscript VA the treatment regime that follows the VA and by subscript * the treatment regime as it was prior to the VA. Patients would prefer a drug in accordance with the VA if $E_{VA}[U] - E_{*}[U] \geq 0$ which is the same as $\theta(p_{*} - p_{VA}) + E[h(z_{VA} - z_{*})] \geq 0$. For simplicity we write this as

$$\theta(\Delta p) + E[\Delta h] \geq 0 \tag{4}$$

Where Δp is the savings from following the guidelines, hereafter referred to as the saving potential. $E[\Delta h]$ is the expected improvement in health status. Patients thus prefer the VA regime if the price savings from doing this is not offset by a reduction in expected health status. By assumption we have that $(\Delta p) \geq 0$ and because $E[\Delta h] \gtreqless 0$ the sign of (4) is not trivial.

Physicians supply

We assume that the physician prescription decision is determined by the cost benefit calculation of the patient and the cost benefit calculation by the insurer weighted by parameters for his loyalty to each of the two principals. Loyalty to the patient is defined by $\gamma \geq 0$ and loyalty to the insurer is defined by $\delta \geq 0$. The insurer has preferences both over the costs of prescription and over the health effect of the prescription. The latter is due to the insurers long run interest in optimal treatment. Inappropriate use drugs would imply higher costs in other areas of the health budget. The GP acta as agent for the insurer and the insurers expectation of health effect is thus identical to the physicians. The physicians belief in the change in patient health status is defined by $E_{GP}[\Delta h]$.

Notice that the insurer pays (1-θ) of the price differential. Physicians will then follow the VA guidelines if

$$\gamma(\theta(\Delta p) + E[\Delta h]) + \delta((1-\theta)\Delta p + E_{GP}[\Delta h]) \geq 0 \qquad (5)$$

The physicians prescription behaviour is according to this simple model a function of the degree of loyalty to the insurer and the patient. The relative weighting of loyalties will determine the relative impact on GP prescription behaviour of the patients belief in change in health status and the extent of co-payment versus the physicians own belief in the change in health status and the cost to the insurer. Notice that we assume that the GPs own income potential does not enter this equation, as we assume that the GP is not a fundholder. Notice from (5) that $f'_{\Delta p} > 0$, $f'_{\gamma} \gtreqless 0$, $f'_{\delta} > 0$, $f'_{E[\Delta h]} \gtreqless 0$, $f'_{E_{GP}[\Delta h]} > 0$ and $f'_{\theta} > 0$ if $\gamma > \delta$.

The VA seeks to directly affect the physicians loyalty to the insurer, δ, and the physicians own belief in the change in health status, $E_{GP}[\Delta h]$.

Empirical model

From (5) we can write the physicians decision as

$$\Pr[s_i^{VA} = 1] = f(\Delta p, \gamma, \delta, \theta, E[\Delta h], E_{GP}[\Delta h]) \quad (6)$$

Where $s_i^{VA} = 1$ when the prescription follows the guidelines in the VA. Lundin used nonlinear models on data at prescription level to analyse a function like (6). Because we want to analyse whether behaviour has changed beyond a specific point in time (after the introduction of the VA) and because we do not have access to data at such a low aggregation level we must find alternative ways of making the empirical analysis operational. Our aim is to derive an empirical model that allows us to measure the GPs prescription behaviour over time. Our point of departure for deriving such a model is to define the total expenditures of GP *i* at time *t* as the sum over D prescriptions

$$c_{it} = \sum_{d=1}^{D} s_{it}^d p_{it}^d \quad (7)$$

Where s_{it}^d defines prescription *d* from GP *i* at *t*. Hence expenditures is determined by the GPs prescription decisions. Because (7) determines aggregate expenditures it is also dependent on the number of patients and the casemix of these patients. The total expenditure can in functional form be defined as

$$c_{it} = g(N, \Delta p, \gamma, \delta, \theta, E[\Delta h], E_{GP}[\Delta h]) \quad (8)$$

Where *N* is the number of patients. Rewrite (8) by multiplying and dividing by the total amount of daily defined doses (DDD) of the specific drug:

$$c_{it} = DDD_{it} \frac{g(\cdot)}{DDD_{it}} = DDD_{it} \bar{p}_{it} \quad (9)$$

Where, $\bar{p}_{it}$, is the average price per DDD which depend on the variables in $g(\cdot)$. Now, $\bar{p}_{it}$ can be thought of as a measure of the composition of the prescription bundle.

Basic model

GPs that comply with the objectives of the voluntary agreement will ceteris paribus have a lower $\overline{p}_{it}$ after the implementation of the agreement. Hence the hypothesis that we want to test is

$$\overline{p}_{is} < \overline{p}_{it} \tag{10}$$

Where $t = 1,\ldots, t^{VA}\text{-}1$ and $s = t^{VA},\ldots,T$ and t^{VA} is the time of implementation of the VA.

Because $\overline{p}_{it}$ is affected not only by the composition of drugs but also by the actual prices at the different points in time, we need to adjust for price changes over time. General price reductions will for example lower $\overline{p}_{it}$ and this should not be interpreted as a measure of a more favourable composition. The most appropriate way to take this potential confounder as well as other confounders into account is to use a control group of GPs that have not been subject to the VA. We use a difference in difference approach and base our analysis on the difference in composition of the GPs prescription bunde ($\overline{p}_{it}$) across the intervention and control groups and over time.

The basic model is

$$p_{it} = c + \beta_1 \text{treat}_i + \beta_2 post_t + \beta_3 \text{DiD}_{it} + \alpha_i + \varepsilon_{it} \tag{11}$$

Where $\overline{p}_{it}$ is the composition of the GPs prescription bundle, *treat* is a dummy equal to 1 if the GP belongs to the intervention county and 0 otherwise, *post* is a dummy which is set equal to 1 for observations after the implementation of VA and *DiD* is the interaction dummy between the two. The latter coefficient (β_3) thus reflects the difference in $\overline{p}_{it}$ that cannot be explained by general time trends or intrinsic differences between the GPs prescription behaviour across the intervention and control group, but must reflect the a difference in prescription behaviour which is associated with the VA intervention. Table 1 below illustrates how the beta korefficients are to be interpreted. From the theoretical model we expect that various GP characteristics affect the prescription behaviour. These unobserved GP specific variables are in this model measured in α_i .

[**Insert table 1**: Interpretation of the difference in difference model]

Subgroup analyses

In order to improve cost effectiveness of future VA interventions, it may be helpful to perform sub-group analyses in order to identify sub-groups of GPs that react to the intervention, and GPs that do not. The theoretical model gives some indication as to what are important determinants of GPs prescription decision. These factors are basically unobserved, but observable GP characteristics may be used as proxies. First, we will argue that the level of saving potential in the period before the intervention is a proxy for the initial weighting of loyalty. GPs with a high saving potential in the period before the intervention can be assumed to have low loyalty to the insurer. From the theoretical model we know that GPs with a higher loyalty to the insurer would ceteris paribus be more willing to adhere to the VA. However, since the VA specifically seeks to increase insurer loyalty (δ), a change in the prescription behaviour amongst this group of GPs would indicate that the intervention has met this goal. A second goal of VA is to provide adequate information on drug profiles to aid the GP in performing appropriate cost benefit calculations. By analysing the impact of the intervention for a subgroup of GPs who initially can be said to have a low quality in prescription behaviour, we focus on whether the intervention is successful in educating and aiding the GPs in a way which improves the quality of the prescription behaviour.

Finally, we wish to test whether the way the GP is organised has an impact on how the GPs react to the intervention. We focus on whether the GP is employed in a solo or group practice. We have no a priori hypothesis of whether GPs working in solo or group practices are more or less adherent to the VA intervention.

The subgroup analyses are based on the following model specification

$$p_{it} = c + \beta_1 treat_i * D_{subgroup} + \beta_2 post_t * D_{subgroup} + \beta_3 DiD_{it} * D_{subgroup} + \alpha_i + \varepsilon_{it} \qquad (12)$$

Where $D_{subgroup}$ is a dummy variable defining the relevant subgroup. Notice that the unobservable physician specific variables are still captured in α_i.

Serial correlation

Bertrand et al. argue that difference in difference models with a large T tend to overestimate the significance of the difference in difference estimate. They show that various methods are available to solve this problem. One strategy is to reduce the number of time periods by collapsing the time series information into a "pre" and a "post" period and assess whether the results are robust to this transformation. The model can be defined as an OLS regression with time and treatment dummies

$$p_i = c + \beta_1 intervention_i + \beta_2 post_t + \beta_3 DiD_{it} + \varepsilon_i \quad i = 1,\ldots, N \text{ , } t = 1,2 \qquad (13)$$

Data

We base our analysis on quarterly data for average prices per DDD, GP loyalty, GP prescription quality and GP organisation (solo or group practice) for the period 2001-2004 for all GPs operating in the Intervention County and control County. The VA focused on prescription behaviour in relation to five different drugs groups; lipid lowering drugs, antidepressants, painkillers for rheumatism, hypertension drugs and ulcer drugs. We analyse the impact of VA on the prescription of lipid lowering drugs (LLD) and drugs for rheumatism treatment. These two drug types differ significantly with respect to the initial potential for cost saving, where the potential is significantly higher for LLD. Also, the context for the intervention was significantly different since the prices for LLD declined substantially due to the expiration of pivotal patents while the cost of rheumatism

drugs remained quite stable in the observed period. Clearly, in an ex ante perspective LLD was the more obvious target for VA, while the impact of VA in the context of rheumatism treatment was less obvious.

The data for the analysis was provided by the Danish Medicines Agency and from the National Health Service statistics. Table 2 gives some general descriptive statistics

[**Insert table 2**: Descriptive statistics]

There are approximately the same number of GPs in each county (94 in the intervention county and 100 in the control county). Taking over the entire period we observe that $\bar{p}_{it}$ is highest in the intervention county for LLD whereas the opposite holds for rheumatism drugs. The share of solo practices is a little higher in the intervention county and the number of different drugs prescribed is very close in the two counties.

Parameters of loyalty and prescription quality

It is often assumed that a large number of different analogue drugs prescribed within LLD and rheumatism treatment is an indicator for poor prescription quality (Bjerrum & Bergman 2001;Chinburapa et al. 1993). We hence use the number of analogue drugs prescribed by a GP as an indicator of poor prescription quality. The indicator is based on a dummy variable of 1 for GPs with a number of different analogue drugs above the 75% quintile. This means that poor quality GPs use more than 5 different analogue drugs for lipid lowering treatment (both intervention and control county GPs) and more than 10 (intervention county) and 11 (control county) different analogue drugs for rheumatism treatment. Poor quality is likely caused by the GPs inability to stay updated

on relative prices, effects and adverse effects for a large spectrum of analogue drugs. We hypothesise that the information provided by the VA by the way of guidelines will change behaviour such that the less expensive but equally effective drugs are chosen.

As a measure of loyalty we use the GPs saving potential and define GPs with a saving potential above the 75% quintile in the period before the intervention as having a low loyalty to the insurer. Table 3 presents the mean saving potential for the various subgroups in the period before the intervention.

[**Insert table 3**: Mean (sd) saving potential for subgroups in intervention county before intervention]

The table shows that solo practices and practices with low prescription quality do not differ from the average practice with respect to the mean saving potential before the intervention.

Results

Figure 1 shows the development of $\overline{p}_{it}$ over the analysed period. It is evident that the curves for the two counties basically follow the same trend. Hence exogenous factors are clearly important for the development of $\overline{p}_{it}$. Furthermore, the figures illustrate that $\overline{p}_{it}$ is higher in the intervention county before the intervention and lower after the intervention. This holds for both drug group and indicates that the intervention might have had a significant effect on the prescription behaviour.

[**Insert figure 1**: Timetrend in $\overline{p}_{it}$]

The empirical models was estimated using both FE and RE estimators. We used the Hausman test to assess whether the RE model provided more efficient estimates. Even though the Hausman test in some cases allows us to reject that RE is more efficient we have presented RE estimates. This is because the FE model does not give us an estimate of the coefficient for treat and because the difference between RE and FE in all cases is not of a magnitude that change the main conclusions. We have also estimated the two period model which as proposed by Bertrand et al takes the possibility of serial correlation into account. The results of these models are discussed but not presented, as the alternative two period model only changes the result in one (out of eight) model specifications. Table 4 shows the results for LLD.

[**Insert table 4**: Results LLD]

When basing our analysis on the full data set we see that the mean p for the control group before the intervention amount to 4.9 Danish kroner. In the intervention country the GPs prescription bundles are slightly more expensive in the pre intervention period (4.9 +0.7 Dkr.). The general time trend (as indicated by the "post" variable) is a reduction in the price per DDD of 1.8 Dkr. After correcting for a general time trend and base-line differences across the intervention and control county, we observe a statistically significant increased reduction in p of 0.8 Dkr (as indicated by the diff coefficient). The overall picture is similar when we perform the analysis on sub-groups. Here, however we see significantly higher impacts of VA for the group of GPs with low loyalty (as defined by a high savings potential). We also observe a higher than average impact amongst GPs who are in solo practices and GPs who exhibit poor quality prescription behaviour.

Table 5 show the results for the rheumatism drugs.

[**Insert table 5**: Results Rheumatism drugs]

The results for lipid lowering drugs are basically replicated in the rheumatism analysis, but the impact of VA is clearly of a lesser magnitude as indicated by the lower Diff coefficients. Also the impact of VA on the group of GPs with low quality prescription behaviour appears to be lower than average.. Notice that are large part of the variation in p is explained by variation between GPs (Rho>0.3). This match well with what was expected from figure 1, where the change over time is modest as compared to LLD.

Discussion

Our analysis were build on a simple theoretical model that assumes that the GPs decision about following the VA depends on a weighted sum of the costs and benefits for the patients and for the insurer. The model illustrates the agency problem faced by the GP. On the one hand the GP need to take the patients preferences and expectation about health effects into account. The GP act as agent for the patient but has to take the patients own expectations about health effect into account in order to reduce patient non compliance. On the other hand the GP needs to take the insures preferences about cost containment into account but as the insurer also prefer optimal treatment because this would save costs in the long run the GP also have to take the health effect into account in this agency perspective. The GP acts as agent for the insurer and therefore he relies on his own expectation on the health effect of the various treatment strategies.

Our results show that the intervention county faces higher prices at baseline, that both drug groups are subject to a declining trend over time. We showed that the intervention results in a significant reduction in average prices at the general level as well as for GPs with low loyalty to the insurer,

with low prescription quality at baseline and for GPs in solo practices. The impact of the intervention is highest on the GPs with low loyalty. This can be explained by the fact that these are the GPs with the highest potential to change. It could however also be thought of as the group of GPs who would be hardest to reach. The GPs with a low prescription quality at baseline had the second highest impact of the intervention. This is an indication of the intervention having an educational influence on the GPs.

Our results are supported by results of a questionnaire answered by GPs by in the intervention county. The questionnaire were developed a s a part of the evaluation carried out by the county itself. The questionnaire show that more than 70% of the GPs answer that they have made more use of analogue substitution after the intervention, 51% had more often neglecting the avoidance of generic substitution and only 3% where disagreeing with the clinical content of the guidelines (Sundhedsforvaltningen 2005).

Our results are further supported by observed changes in the composition of the prescription bundles. A main point in the guidelines for lipid treatment was to increase the use of Simvastatin. Measured in defined daily doses (DDD) Simvastatin's share of the lipid lowering drugs increased from 35 % in the third quarter of 2002 to 76 % in the third quarter of 2004. Regarding the drugs for rheumatism the main message in the guideline was to reduce use of expensive COX-2 inhibitors. The COX-2 inhibitors' share of DDD increased rapidly before the intervention, peaked in the third quarter of 2003 with 32 % and decreased thereafter. In the fourth quarter of 2004 it dropped to 11 % of the total prescription. The COX-2 inhibitors were discontinued in the end of 2004, and it seems as if the drop in their share appeared before they were discontinued from the market (Sundhedsforvaltningen 2005).

Conclusion

In this paper we extend the models of generic prescription by Hellerstein (1998) and Lundin (2000) to allow for analogue substitution and present an empirical model based on differences in differences in the price of drugs before and after implementation of the voluntary agreement.

For two drug groups (lipid lowering drugs and drugs for rheumatism) we find evidence of a significant reduction in the costs associated with the prescription behaviour of the GPs from the intervention county. The intervention is found to have a larger impact on the prescription behaviour of GPs with low loyalty to the insurer, with low prescription quality and GPs in solo practices.

Earlier studies of interventions aimed at changing the prescription behaviour of Danish GPs have shown no significant effect. We conclude that the effectiveness of the voluntary approach may be due to the indirect effect on the GPs altruistic motivation, which make the GPs and the authorities collude in a common agency role.

References

Bjerrum, L. & Bergman, U. 2001, "[How many prescription drugs does a general practitioner handle? A prescription database study]", *Ugeskr.Laeger*, vol. 163, no. 24, pp. 3342-3346.

Busse, R., Schreyogg, J., & Henke, K. D. 2005, "Regulation of pharmaceutical markets in Germany: improving efficiency and controlling expenditures?", *Int.J Health Plann.Manage.*, vol. 20, no. 4, pp. 329-349.

Chinburapa, V., Larson, L. N., Brucks, M., Draugalis, J., Bootman, J. L., & Puto, C. P. 1993, "Physician prescribing decisions: the effects of situational involvement and task complexity on information acquisition and decision making", *Soc.Sci.Med.*, vol. 36, no. 11, pp. 1473-1482.

Coast, J. 2001, "Citizens, their agents and health care rationing: An exploratory study using qualitative methods", *Health Economics*, vol. 10, pp. 159-174.

Delneij, D. & Brenner, G. 2000, "Importing budget systems from other countries: what can we learn from the German drug budget and the British GP fundholding", *Health Policy*, vol. 52, pp. 157-169.

Dixon, J. 1997, "France seeks to curb health costs by fining doctors. Heavy handed and expensive", *British Medical Journal*, vol. 315, pp. 895-896.

Drummond, M. & Jönsson, B. 2003, "Moving Beyond the Drug Budget Silo Mentality in Europe", *Health Policy*, vol. 6, p. S74-S77.

Dusheiko, M., Gravelle, H., Jacobs, R., & Smith, P. 2006, "The effects of financial incentives on gatekeeping doctors: Evidence from a natural experiment", *Journal of Health Economics*, vol. 25, pp. 449-478.

Granlund, D., Rudholm, N., & Wikström, M. 2006, "Fixed bud gets as a cost containment measure for pharmaceuticals", *European Journal of Health Economics*, vol. 7, pp. 37-45.

Hellerstein, J. 1998, "The importance of the physician in the genric versus trade-name prescription decision", *The Rand Journal of Economics*, vol. 29, no. 1, pp. 108-136.

Lundin, D. 2000, "Moral Hazard in physician prescription behavior", *Journal of Health Economics*, vol. 19, pp. 639-662.

Søndergaard, J., Andersen, M., Kragstrup, J., Hansen, H., & Gram, L. 2002, "Why has postal prescriber feedback no substantial impact on general practitioners' prescribing practice? A qualitatity study", *European Journal og Clinical Pharmacology*, vol. 58, pp. 133-136.

Sundhedsforvaltningen 2005, *Bedst og Billigst - Medicinindsatsen i Roskilde Amt*.

Table 1: Interpretation of the difference in difference parameters

	Before intervention	After intervention	Difference
Intervention county	$C+\beta_1$	$C+\beta_1+\beta_2+\beta_3$	$\beta_2+\beta_3$
Control county	C	$C+\beta_2$	β_2
Difference	β_1	$\beta_2+\beta_3$	β_3

Table 2: Descriptive statistics

Variable	Intervention county		Control county	
	LLD Mean, sd	Rheumatism Mean, sd	LLD Mean, sd	Rheumatism Mean, sd
N	94	94	100	100
T (month)	48	48	48	48
$\bar{p}_{it}$	6.7, 3.0	4.6, 1.1	6.4, 2,6	4.7, 0.9
Number of patients	1399, 410	1395, 411	1365, 407	1365, 407
Share of solo practices	54 %	54 %	45 %	45 %
Number of different drugs prescribed	4.4, (1.6)	8.7, (2.5)	4.5, (1.6)	9.8, (2.5)

Table 3:Mean (sd) saving potential for subgroups in intervention county before intervention

	LLD		Rheumatism	
	N	Saving potential	N	Saving potential
Organisation, solo	52	4.3 (2.1)	52	4.0 (1.2)
Loyalty to insurer	24	4.7 (2.3)	24	5.2 (0.9)
Prescription quality	24 (4)	4.3 (1.7)	24 (10)	4.1 (0.8)
All	97	4.3 (1.9)	97	3.9 (1.2)

Figure 1: Timetrend in mean price per DDD

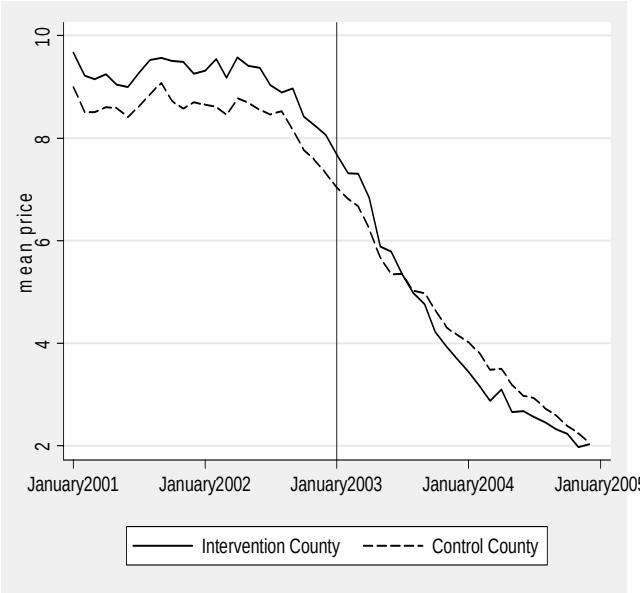

Figure 2a: Lipid Lowering drugs

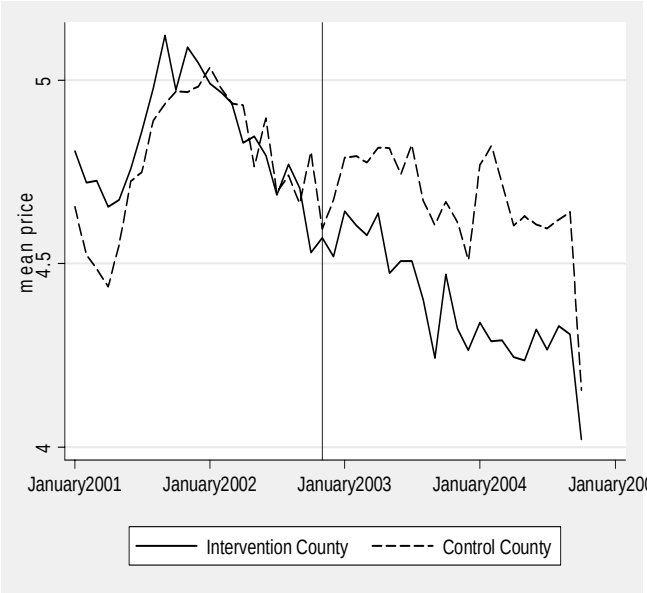

Figure 2b: Rheumatism drugs

Table 4: LLD

	All GPs	Low loyalty group	Low quality group	GPs in solo practices
	RE	RE	RE	RE
Constant	4.9*	6.6*	6.8*	7.11*
Treat	0.7*	3.3*	2.3*	2.0*
Post	-1.8*	-3.1*	-3.1*	-3.7*
Diff	-0.8*	-2.9*	-1.9*	-1.6*
R2	0.41	0.17	0.16	0.30
Rho	0.06	0.02	0.03	0.17

Table 5: Results Rheumatism

	(1)	(2)	(3)	(4)
	RE	RE	RE	RE
Constant	3.8*	4.6*	4.7*	4.7*
Treat	0.05*	1.4*	0.3	0.2*
Post	-0.3*	-0.3*	0.1	-0.1*
Diff	-0.3*	-0.5*	-0.05*	-0.4*
R2	0.05	0.10	0.02	0.01
Rho	0.60	0.39	0.59	0.59