Reference Pricing or Price Cap Regulation of Pharmaceuticals?

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Abstract

We study the relative performance of generic reference pricing (GRP) and price cap regulation using a unique policy experiment from Norway. In 2003 Norway introduced a GRP system called 'index pricing' for a subsample of off-patent pharmaceuticals, replacing a price cap system based on international price comparisons. Unlike most other GRP systems, the pharmacies were exposed to all incentives; not only did they keep the savings from selling a (generic) drug with a price below the reimbursement level, but they also had to bear the cost of selling a (brand-name) drug with a price above the reimbursement level. We use a product level panel dataset covering the drugs exposed to index pricing and comparison group consisting of therapeutic substitutes and unrelated drugs still under price cap regulation, before and after the policy experiment. We find that the GRP system significantly reduced both brand-name and generic prices within the reference group, but also had a price reducing effect on the non-included therapeutic substitutes.

Keywords: Pharmaceuticals; Price Regulation; Generic competition

JEL Classification: I11; L13; L51; L65

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1 Introduction

Pharmaceutical markets are characterised by price inelastic demand, mainly due to extensive medical insurance, and supply-side market power associated with the patent system protecting new chemical entities from being copied within a given period. This combination has lead most countries to exert various means to curb the pharmaceutical firms' market power and to control the growth in medical expenditures.[1] We can distinguish between two different price control mechanisms: (i) regulation of drug prices by enforcing price caps; and (ii) regulation of the reimbursement level, frequently referred to as *reference pricing*. While price caps limit pharmaceutical firms' ability to exploit market power by charging high prices, reference pricing systems aim at stimulating competition by making demand more price elastic.

The price cap on pharmaceuticals is determined in many ways. Ideally, the price cap level of a particular drug should reflect the therapeutic benefit, the R&D and production costs, and, potentially, the costs of public funds. Instead, many countries, including Norway, apply the increasingly popular scheme called international reference pricing. This scheme makes use of international price comparisons, where the price cap of a particular drug is determined by the lower prices of this drug in a set of "comparable" countries.

Under reference pricing, however, the pharmaceutical firms are free to set their prices at any level. Instead the reimbursement level is regulated. Drugs are classified into clusters based on therapeutic effect. The clusters may be narrowly or widely defined. A narrow definition is to cluster drugs with the same active chemical ingredients only, called generic reference pricing (GRP). A wider definition includes products with different chemical ingredients but comparable therapeutic effects (therapeutic substitutes), called therapeutic reference pricing (TRP). The reference price, which is the maximum reimbursement for all products in the cluster, is typically based on a relatively low-priced drug in the cluster. Thus, (brand-name) drugs with prices above the reference price, are subject to surcharges, which in most reference price systems are imposed on the patients.

Price regulation of pharmaceuticals is a widely debated issue. However, little is known about

[1] Danzon (1997) provides an excellent overview and discussion of various regulatory mechanisms and their purposes in the pharmaceutical industry.

the performance of the different systems.[2] This paper exploits a unique policy experiment from Norway. In 2003 the government introduced a GRP system, called 'index pricing', to a subsample of the off-patent pharmaceuticals, replacing a price cap system based on international reference pricing. We make use of a product-level panel dataset over a four-year period, covering the years 2001-2004, which means that we have information on drug prices before and after the policy experiment. Moreover, the dataset includes not only the drugs exposed to index pricing, but also a significant set of drugs still subject to price cap regulation. This latter group consists of therapeutic substitutes and drugs that are unrelated in consumption, which may or may not be under patent protection. The comparison group enables us to identify potential cross-price effects between the drugs subject to the GRP system and their therapeutic substitutes.

We find that the index price system had a strong price reducing effect on both the brand-name drugs and the generic drugs subject to this regime. Depending on the choice of comparison group (and time specification), the GRP system induced a price reduction on the brand-names between 24 to 31 percent, and on generics between 13 to 19 percent. This result demonstrates that the GRP system induced fierce price competition between branded and generic drugs exposed to the system. It also indicates that GRP systems are more effective than price cap systems in reducing public and private medical expenditures.

We also identify a negative cross-price effect of the index price system on the therapeutic substitutes still under price cap regulation. In contrast to the drugs exposed to GRP, the price reduction is more pronounced for generics than for brand-name drugs. The GRP system induced a price reduction on generics in the therapeutic substitute group of 12.5 percent, while the same figure for the brand-name substitutes is 5.9 percent. The weaker effect on brand-names is most likely due to a binding price cap.

2 Related Literature

The literature on performance of price regulation regimes are limited and mainly descriptive, and there is a pronounced lack of theoretical and empirical studies of potential effects of the

[2] According to the extensive literature survey by Lopez-Casasnovas and Puig-Junoy (2001), the bulk of the RP literature is mainly descriptive. See also Danzon (2001).

different studies.[3] Our paper is a contribution in that respect. There are, however, some notable exceptions. Below we relate our paper to these.

Our paper is primarily concerned with price effects of generic reference pricing compared with a price cap regime. Danzon and Lui (1996) argues that all (the brand-name and generic) prices within the reference cluster will converge towards the reference price, implying a price decrease on the high-price (brand-name) drugs and a price increase on the low-priced (generic) drugs. The reason is that in most GRP systems, the patients have to pay the surcharges when demanding an expensive (brand-name) drug, but do not obtain any benefits from demanding cheaper (generic) drugs. In this case, the demand curve is elastic above the reference price, kinked at the reference price, and perfectly inelastic below the reference price.

Our results do not support the price convergence hypothesis. We find that both the brand-name and the generic drug prices are substantially reduced following the introduction of the index price system. In the Norwegian system, the patients were not exposed to any surcharges. Instead all incentives were put on the pharmacies, which not only kept the margin from selling a drug at price below the reference price, but also had to bear the full cost of selling a drug priced above the reference price. If we, for the sake of exposition, include the pharmacies on the demand-side, as we do with physicians, the demand curve associated with the index price system is continuous (or smooth), and not kinked as suggested by Danzon and Liu (1996).

A related empirical study by Pavcnik (2002) derives a similar result to ours. Analysing the policy change in Germany from "free pricing" towards a therapeutic reference pricing, she identifies a strong price decrease for both brand-name and generic drugs, with the price decrease being more pronounced for the former group. While we apply a somewhat similar approach to identify the effects of the Norwegian GRP system, the studies differ quite significantly. In particular, Pavcnik (2002) considers the effect of the change on the patients' out-of-pocket expenses on the pharmaceutical firms price setting. The Norwegian GRP system did not change the patients' out-of-pocket expenses, and the benchmark is not "free pricing", as in Germany. Our paper is instead concerned with the price effects of a GRP system – exposing the pharmacies to all incentives – compared with price cap regulation.

[3] See Danzon (1997) for a general overview of the literature on price regulation of pharmaceuticals. On the reference price systems, in particular, the extensive literature survey by Lopez-Casasnovas and Puig-Junoy (2000) explicitly states this concern. See also Danzon (2001).

There exists a recent paper by Dalen et al. (2005) analysing the Norwegian index pricing system. They estimate a structural model to analyse the impact of the reform on both demand and market power, showing that the index price system increased the market shares of the generic drugs and triggered price competition. However, they only have data on the six chemical substances subject to the GRP system, and for a limited (22) number of pharmacies. Our dataset includes, besides the six chemical substances, a wide set of drugs – both therapeutic substitutes and drugs that are unrelated in consumption – which enables us to clearly identify the net price effects of the index pricing system, and assess the relative performance of the GRP system and the price cap system. In addition, we provide evidence on a negative cross-price effect of the GRP system on the therapeutic substitutes still under price cap regulation, which indicates that the study by Dalen et al. (2005) focusing only on the drugs exposed to the GRP system tend to under-estimate the total price, and thus cost-saving, effect of this system.

GRP is considered to be uncontroversial (in contrast to TRP) for two reasons (see e.g., Lopez-Casasnovas and Puig-Junoy, 2000). First, since it only applies to drugs with the same active chemical substances, the health risks to patients associated generic substitution are considered to be very limited. Second, since GRP applies by definition to off-patent drugs only, it is perceived to not affect the patent protection, and thus market entry and innovation decisions. A theoretical paper by Brekke et al. (2005) show that this is not necessarily true. Using a model combining generic and therapeutic competition, they find that GRP exposes patients to higher health risks than TRP (and free pricing) since it results in the largest differences in out-of-pocket payments. Moreover, they show that GRP not only triggers lower prices for the chemically equivalent drugs, but also has a price decreasing effect on the therapeutic substitutes, with the magnitude depending on the degree of substitutability.

Our paper is not able to test the effect of GRP on neither the patients' health risk nor the market entry and innovation incentives of the firms.[4] However, we provide evidence on a negative cross-price effect of the GRP system on therapeutic substitutes not subject to this system. This confirms the concern with GRP systems, raised by Brekke et al. (2005), that it may influence the patent protection. The cross-price effect is, however, much weaker than the

[4] A paper by Danzon and Ketchham (2004) analyses the effect of reference pricing on the availability of drugs in Germany, the Netherlands and New Zealand, providing results that indicates that the strictness of the RP systems tend to lower the number of drugs available in a country.

direct price effect on the drugs subject to index pricing, which is consistent with Ellison et al. (1997) and Pavcnik (2002).

3 The Norwegian Pharmaceutical Market

The Norwegian pharmaceutical market is extensively regulated, as most other countries. The regulatory body is the Norwegian Ministry of Health and Care Services and its agency called the Norwegian Medicines Agency. Norway has adopted the European patent law system to a large extent, such that all new chemical entities are subject to patent protection for a given period. However, the pharmaceutical firms still need government approval to launch a new product in Norway. In addition, they must submit an application providing sufficient evidence of benefits compared with costs from the drug therapy in order to get the drug listed in the reimbursement system (the blue list). Once this is obtained, the prices are subject to price control.

The current system is a *price cap* scheme based on international reference pricing. This system was introduced in 2001, and covers all prescription drugs, both on-patent and off-patent, except for those included in the index pricing system.[5] The price cap is defined as the weighted sum of the three lowest prices of a specific drug in a basket of countries that is "comparable" to Norway.[6] The price cap is imposed at the wholesale level, leaving the producer prices unregulated. The government then defines a maximum product-specific mark-up, which in turn determines the price cap on the retail price of each product.

The *index pricing* scheme was introduced in March 2003 for a subsample of off-patent pharmaceuticals facing generic competition. Initially, the index price system covered six chemical substances: Citalopram (depression), Omeprazol (antiulcer), Cetirizin (allergy), Loratadin (allergy), Enalapril (high blood pressure), Lisinopril (high blood pressure). In June 2004 Simavastatin (high cholesterol) was included. The government decided to terminate the system by the end of 2004, arguing that the expected cost savings did not materialise. Thus, in total the system run for almost two years.

[5] Over-the-counter (OTC) drugs are not subject to any price regulation, so the pharmaceutical firms can freely set the prices on these group of drugs.

[6] The following countries are included in the Norwegian basket: Austria, Belgium, Danmark, Finland, Germany, Irland, the Netherlands, Sweden and the UK. Thus, Southern and Eastern Europian countries, as well as, France and Swiss, are excluded. If there are no prices yet in these countries, the price is determined by negotiations based on the provided evidence on benefit and costs of the medical treatment in question.

The index price was calculated as follows. First, the drugs were classified into clusters based on chemical substance. Then within each cluster, the drugs were classified into subgroups depending on the package size and dosage in order to adjust for cost variation. Second, the index price was calculated as the sales weighted sum of producer prices of the drugs included in each subgroup. For the six chemical substances initially included, there were 16 index prices in total. This exercise were repeated every three months, resulting in a revised index price for every quarterly. Formally, the index price for a given period t, denoted by I^t, can be defined as:

$$I^t = \sum\nolimits_{i=1}^{N} \left[M_i^{t-1} \cdot p_i^{t-1} \right], \quad \text{where } M_i^{t-1} = \frac{q_i^{t-1}}{\sum_{j=1}^{N} q_j^{t-1}}.$$

where p_i^{t-1} is the producer price of product i in the previous period, i.e., $t-1$, q_i^{t-1} is the quantity sold of product i in the previous period, measured in tablets or defined daily doses (DDD), and, thus, M_i^{t-1} is the market share of product i in the previous period. Since each period t lasts for three months, all variables are average values. The index price was the maximum reimbursement for every drug in the reference group. We see that the index price is reduced if lower-priced (generic) drugs increase their market share, and/or if there is a price decrease of the higher-priced (brand-name) drugs and/or the lower-priced (generic) drugs generic in the cluster.

A special feature of the index price system relative to other reference price systems is that the pharmacies were exposed to all incentives. Not only did they keep the margin of selling a (generic) drug with a price lower than the index price, but they also had to bear the full cost of selling the a (brand-name) drug with a price higher than the index price. Importantly, generic substitution was allowed in 2001, so the pharmacies could suggest a cheaper (generic) drug, although the physician had written a brand-name drug on the prescription (which they frequently tend to do). If the patient refused to accept a generic substitution, the patient had to pay the surcharge associated with the difference between the high-priced (brand-name) drug and the index price. On the other hand, the physicians could blockade generic substitution by actively writing an argument on the prescription of why this particular patient is better off with the expensive (brand-name) drug.

In Norway there is a statutory public health insurance, covering the whole population. Close to 70 percent of the total drug expenses are covered by this insurance scheme. For prescription

drugs on the reimbursement list (the blue list), patients pay a fixed share (36 percent) of the drug price, constrained by a maximum amount per prescription (400 NOK) and per year (1.350 NOK). Notably, the patients' copayments are not affected by the index price system – as all incentives are imposed on the pharmacies – except for the case when the patient refuses to accept a cheaper (generic) substitute. Then the patient must pay the difference between the reference price and the actual price of the drug, as common in reference price system. In addition, the physicians can blockade generic substitution by actively claim on the prescription that the patient is better-off with the expensive (brand-name) drug, but an argument is needed.

4 Data and Descriptive Results

4.1 Data

In the empirical analysis we use data from Farmastat.[7] Their database includes information on value and volume for each package of drugs sold at the Norwegian pharmaceutical market. Values are in pharmacy purchase prices and volumes in defined daily doses (DDD) for the active substance (ATC-code). The database also provides information about product name, manufacturer, launch date, price cap, whether the product is a brand-name or a generic drug, etc.

From this database we have data on all prescription drugs within the 30 largest (in terms of volume) ATC-groups over a four year period from 2001 to 2004. Table 1 lists ATC-code, brand-name, and manufacturer of these pharmaceuticals. The table also gives information about whether the drugs within each ATC-code are subject to reference pricing or not, whether the branded drug faces generic competition or not, and whether or not it is classified as a therapeutic competitor to a drug in the reference price group. This last classification is based on therapeutic categories. For example, Losec with ATC-code A02BC01 is included in the index price system, and therefore all pharmaceuticals with A02 as the first three characters in the ATC-code are classified as therapeutic competitors to Losec.

[Table 1 about here]

[7] Farmastat is a company specialised in provision of pharmaceutical statistics. The company is owned by the Norwegian Association of Pharmaceutical Manufacturers.

In our analysis, we define a product as all presentations of a given drug produced by a given manufacturer. For example, the brand-name Zantac together with five generic products give a total of six products in ATC-group A02BA02. For each product, prices are calculated as total sales values divided by the total volume sold (in DDD). All prices therefore refer to average prices per defined daily dose of the active ingredient; a price measure that enables comparison across different formulations (tablets, capsules, etc.) within each product, and also across different active ingredients. Time is divided into two-month periods, and the average price of each product in each time-period constitutes an observation provided that the product is present in our data. The number of observations within each ATC-group is given in the last column in Table 1. The total number of observations in our analysis is 1415.

4.2 Descriptive results

A natural starting point for the descriptive analysis is to look at how average prices have developed over time. In Figure 1, we plot average prices for brand-names and generics for the following three groups of pharmaceuticals: (i) the pharmaceuticals subject to generic reference pricing, (ii) the drugs that are therapeutic substitutes still under price cap regulation, and (iii) the others, which are independent in consumption and exposed to price cap regulation.

[Figure 1 about here]

With time measured in two month periods, the reference price regulation was introduced in period 13 in the figure. Average prices of pharmaceuticals subject to reference pricing display a pronounced decrease after the implementation of the reform. In Table 2, we have calculated the average price in the periods before and after the implementation of the index price system. We find that average prices in the pre-regulation period is about 4.7 NOK, while average prices during reference pricing is about 3.3 NOK. This implies a price reduction of more than 29 percent. Turning to the therapeutic competitor group, we find a somewhat similar price pattern as in the group of pharmaceutical subject to GRP prior to the reform, but the decrease in average prices after the regulation is much smaller, about 12 percent. The average prices in the "others" group show a quite different price pattern; a large decline in the first part of the

reference price period is followed by an increase in the second part of this period.

[Table 2 about here]

To get a better understanding of the price patterns depicted in Figure 1, we plot the average prices of brand-names and generics together with the average price cap for the three groups. In Figure 2, we see that the average price of the brand-name drugs has been steadily decreasing after the implementation of the reference price regulation. Interestingly, in the pre-regulation period, average prices of generic drugs follow almost the same price pattern as brand-name pharmaceuticals.

[Figure 2-4 about here]

From Figure 3 and 4, we see that average prices of brand-names in the therapeutic competitor group and the "others" group follow the maximum price over the entire period. This indicates that the generic reference price regulation had a small, if any effect on the price setting of brand-name drugs in the group of pharmaceuticals not directly affected by the regulation. However, average prices of generic drugs in the therapeutic competitor group follow the same pattern as prices for generics in the reference pricing group. This indicates that much of the price reduction in the therapeutic competitor group is explained by a reduction in prices on generic drugs.

5 Empirical Analysis

5.1 Design and econometric model

We estimate the effect of introducing index pricing on product level prices by comparing inter-temporal variation in (log) prices before and after imposition of the reform. Identification relies not only on before-after comparison, but also on comparison of price variation for drugs subject to the reform with price variation for comparable drugs not subject to the reform.

Ideally, in order to estimate the effect on prices of introducing index pricing on the products affected by the reform, we would like to know what the prices on these products would have been had the reform not been imposed on them. Since we only can observe prices for these products with the imposed reform, we let the prices for a set of other comparable products represent the

counterfactual. For this specific reform comparable products are first and foremost products within other therapeutic substances with a broad spectre of presentations and their generic substitutes. However, since we also are interested in whether or not the reform has an impact on therapeutic substitutes, branded as well as generic, we also include such among the products selected for the comparison group.

We employ the following semi-logarithmic specification:

$$\begin{aligned} \log\ (P_{it}) &= \alpha_0 + \textstyle\sum_{t=1}^{T} \alpha_t D_t + \beta_1 GRP_{it} + \beta_2 GRP_{it} * B_i + \beta_3 GRPP_{it} * TS_i \\ &\quad + \beta_4 GRPP_{it} * B_i * TS_i + \beta_5 H_{it} + \beta_6 NG_{it} + \beta_7 PCAP_{it} + a_i + \varepsilon_{it}, \end{aligned} \tag{1}$$

where the D's are period indicators. GRP is an indicator of whether product i is subject to the GRP-system at time t. For products in six of the seven chemical substances included in the index price system the variable equals zero for $t = 1, ..., 13$, and one for $t = 14, ..., 24$. For products in the seventh substance that was included in September 2004, the variable equals zero up to period 22 and one thereafter. GRP is equal to zero in all time periods for all other products. $GRP * B$ is an interaction between GRP and an indicator of whether or not the product is a brand-name product. Furthermore, we define a variable $GRPP$ equal to zero for all time periods before the GRP system was introduced, and one thereafter. In the regression, this variable is interacted with a variable TS, indicating whether or not a product is a therapeutic substitute to the products exposed to the GRP system. We also include the interaction $GRPP * B * TS$ in order to capture the difference in effect on branded versus generic therapeutic substitutes. We augment equation (1) with the variable H, which is the Herfindahl index, measuring the degree of market concentration within a chemical substance group, the variable NG, which measures the number of generic products, and $PCAP$, which is the average price cap. Note that i for these three variables refer to the chemical substance group, and not the particular product i. Finally, a_i is a product fixed effect, and ε_{it} represent measurement errors in prices or unobserved factors that affect prices.

We employ the fixed effect estimator, and compute robust standard errors adjusted for clustering on product level.[8] The standard errors are robust to the presence of general forms of

[8] Note that one base time period had to be excluded in the models estimated with time periods.

heteroscedasticity and also accounts for potential serial correlation within products over time.

5.2 Empirical Results

We start out by estimating fixed effects based on a more simple version of equation (1), where we only include GRP, $GRP * B$, and alternative time-specifications, i.e. time periods, year-dummies or a time-trend variable. The three different models are estimated when including all products not exposed to GRP in the comparison group, when including only therapeutic competitors and when excluding therapeutic competitors.

Results reported in Table 3 show that the introduction of GRP significantly (1%-level) reduces prices on generics, as well as branded products included in the system. Depending on the choice of time specification and comparison group the effect on prices on generic substitutes vary between -13.1 percent and -19.3 percent, whereas the reduction in prices for the branded products is even stronger (the sum of β_1 and β_2) varying between -24.1 percent (column 4) and -30.9 percent (column 8).[9] We see that the estimated effects of introducing GRP are smaller when only including therapeutic substitutes among the comparison group members. This may indicate that prices on therapeutic substitutes too are affected by the introduction of the GRP system.

We now estimate the full model when using time period dummies, and including all other products among the comparison group members. Fixed effect estimates are reported in Table 4 when including one additional variable at a time. The estimates of the effects of the reform are robust to the inclusion of other variables and remain statistically significant at the 1%-level. In column 5 in the table, results are reported for the full model. We see that when controlling for over time changes in the price cap, and changes in market structure and competition, the reform on average has resulted in a 20.1 percent decrease in prices on generic substitutes, and a 30 percent decrease in prices on branded products. In addition, these results show that, on average, prices on therapeutic substitutes not included in the reform have responded to the reform as well. The effect is strongest for therapeutic generic substitutes, for which prices on average are reduced by 12.5 percent. For branded therapeutic competitors, prices are on average

[9] We also estimated the models when including only therapeutic substances with a broad spectre of presentations and their generic substitutes in the comparison group. The results did not differ substantially from those reported in Table 3.

reduces by 5.9 percent. These effects too, are statistically significant at the 1% level.

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Appendix A: Tables and Figures

Table 1: Sample characteristics

ATC-group	Drug subject to reference pricing	Therapeutic competitor	Brand name	Manufacturer	Number of generics	Number of observations
A02BA02	No	Yes	ZANTAC	GLAXOSMITHKLIN	5	128
A02BC01	Yes	No	LOSEC	ASTRAZENECA	1	43
A02BC03	No	Yes	LANZO	WYETH-LEDERLE	0	24
A02BC05	No	Yes	NEXIUM	ASTRAZENECA	0	24
C07AB02	No	No	SELO-ZOK	ASTRAZENECA	2	66
C07AB03	No	No	TENORMIN	PFIZER	5	121
C09AA02	Yes	No	RENITEC	MSD	3	77
C09AA03	Yes	No	VIVATEC	ASTRAZENECA	3	103
			ZESTRIL	MSD		
C09BA02	No	Yes	RENITEC COMP	MSD	1	36
C09CA01	No	Yes	COZAAR	MSD	0	24
C09DA01	No	Yes	COZAAR COMP	MSD	0	24
C10AA01	Yes (1.6.2004)	No	ZOCOR	MSD	2	42
C10AA03	No	Yes	PRAVACHOL	B-MYERS SQUIBB	0	24
C10AA05	No	Yes	LIPITOR	PFIZER	0	24
G04BE03	No	No	VIAGRA	PFIZER	0	24
L02BB03	No	No	CASODEX	ASTRAZENECA	0	24
M01AH01	No	No	CELEBRA	PFIZER	0	24
M01AH02	No	No	VIOXX	MSD	0	23
M05BA04	No	No	FOSAMAX	MSD	0	24
N02BE01	No	No	PANODIL	GLAXOSMITHKLIN	5	120
N02CC01	No	No	IMIGRAN	GLAXOSMITHKLIN	0	24
N05AH03	No	No	ZYPREXA	ELI LILLY	0	24
N06AB04	Yes	No	CIPRAMIL	LUNDBECK	3	57
N06AB05	No	Yes	SEROXAT	GLAXOSMITHKLIN	1	28
N06AB06	No	Yes	ZOLOFT	PFIZER	0	24
N06AX03	No	Yes	TOLVON	ORGANON	1	48
R03AK06	No	No	SERETIDE	GLAXOSMITHKLIN	0	24
R03AK07	No	No	SYMBICORT	ASTRAZENECA	0	22
R06AE07	Yes	No	REACTINE	PFIZER	2	76
			ZYRTEC	UCB		
R06AX13	Yes	No	CLARITYN	SCHERING-PLOUGH	4	89
Total					37	1415

Table 2: Average prices before and after generic reference pricing.

	Prices before	Prices after	Percentage price change
Drug subject to reference pricing	4.68 (3.04)	3.31 (2.21)	-29.27%
Therapeutic competitors	6.96 (2.79)	6.11 (2.52)	-12.22%
Other drugs	14.21 (16.93)	13.55 (16.15)	-4.64%

Table 3: Price effects of generic reference pricing. Fixed effect results with robust standard errors.

	Control group: Therapeutic competitors ant others group			Control group: Therapeutic competitors			Control group: Others group		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Products subject to reference pricing	-.163**	-.177**	-.170**	-.131**	-.158**	-.152**	-.151**	-.188**	-.193**
	(.028)	(.027)	(.027)	(.029)	(.028)	(.029)	(.029)	(.028)	(.028)
Branded products subject to reference pricing	-.117**	-.125**	-.124**	-.110**	-.126**	-.122**	-.114**	-.121**	-.115**
	(.041)	(.039)	(.036)	(.040)	(.038)	(.034)	(.040)	(.038)	(.035)
Product dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time trend	Yes	No	No	Yes	No	No	Yes	No	No
Year dummies	No	Yes	No	No	Yes	No	No	Yes	No
Period dummies	No	No	Yes	No	No	Yes	No	No	Yes
Number of observations	1415	1415	1415	895	895	895	1007	1007	1007
Number of products	69	69	69	46	46	46	50	50	50
R-squared (within)	.30	.32	.36	.37	.42	.48	.35	.38	.43

*: significant at the 5% level. **: significant at the 1% level.

Table 4: Price effects of generic reference pricing when controlling for competition and price cap regulation. Fixed effect results with robust standard errors.

	(1)	(2)	(3)	(4)	(5)
Products subject to reference pricing	-.186**	-.221**	-.222**	-.200**	-.201**
	(.024)	(.025)	(.025)	(.027)	(.027)
Branded products subject to reference pricing	-.106**	-.106**	-.106**	-.097**	-.099**
	(.032)	(.032)	(.032)	(.032)	(.032)
Price cap	.064**	.065**	.066**	.066**	.066**
	(.004)	(.004)	(.004)	(.004)	(.004)
Therapeutic competitors* reference period		-.086**	-.137**	-.129**	-.125**
		(.014)	(.025)	(.026)	(.026)
Branded therapeutic competitors* reference period			.076**	.069**	.066**
			(.025)	(.025)	(.025)
Herfindahl-index/100				.001**	.001*
				(.000)	(.000)
Number of generics					.011
					(.011)
Product dummies	Yes	Yes	Yes	Yes	Yes
Period dummies	Yes	Yes	Yes	Yes	Yes
Number of observations	1415	1415	1415	1415	1415
Number of products	69	69	69	69	69
R-squared (within)	.55	.56	.56	.57	.56

*: significant at the 5% level. **: significant at the 1% level.

Figure 1: Average prices of the drugs exposed to GRP, as well as therapeutic competitors and unrelated drugs subject to price cap regulation

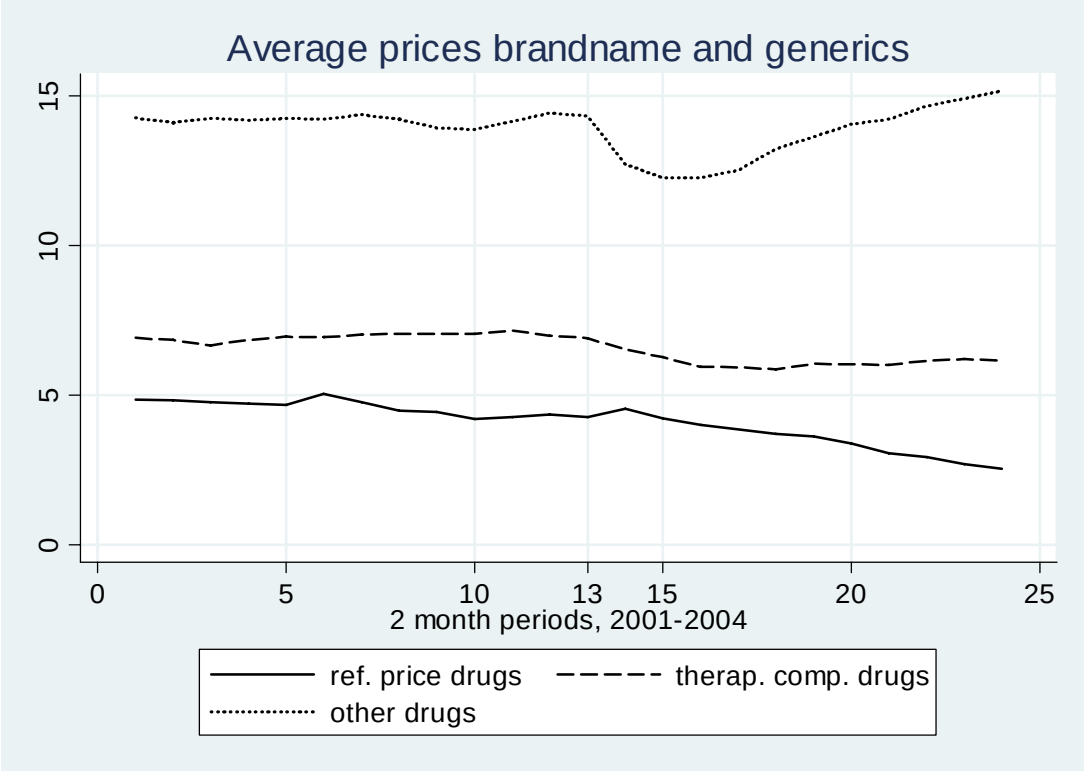

Figure 2: Average prices of drugs exposed to GRP, decomposed on brand-names and generics (including the non-enforced price cap on these drugs)

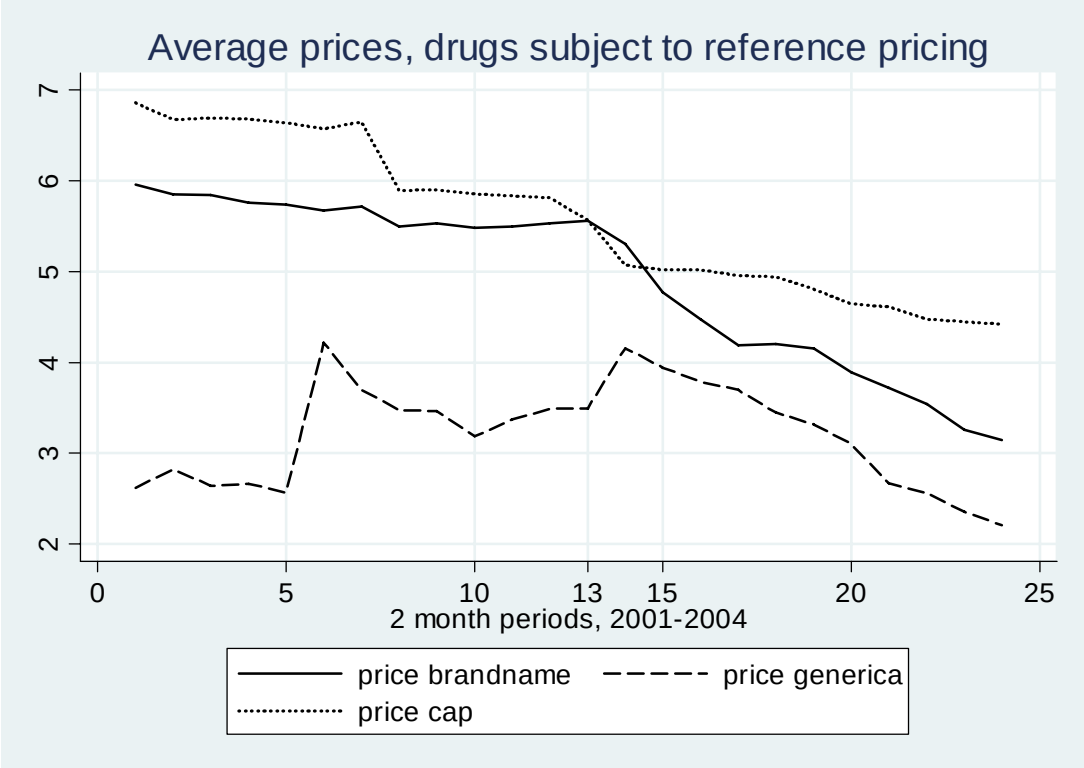

Figure 3: Average drug prices of the therapeutic substitutes subject to price cap regulation, decomposed on brand-names and generics

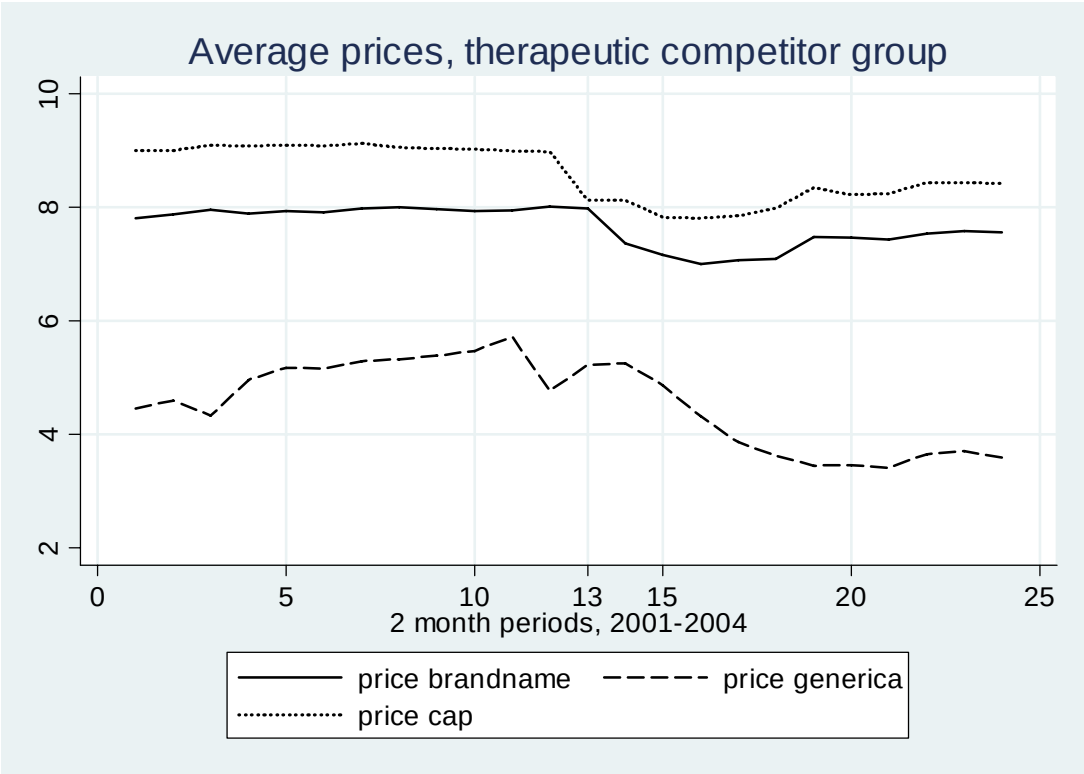

Figure 4: Average prices of the residual group consisting of unrelated drugs subject to price cap regulation, decomposed on brand-names and generics.