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Pharmaceutical Promotion and GP Prescription Behaviour

Frank Windmeijer, Eric de Laat, Rudy Douven, Esther Mot

CPB Netherlands Bureau for Economic Policy Analysis
Van Stolkweg 14
P.O. Box 80510
2508 GM The Hague, the Netherlands

Telephone +31 70 338 33 80
Telefax +31 70 338 33 50
Internet www.cpb.nl

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Abstract

The aim of this paper is to empirically analyse the responses by general practitioners to promotional activities for pharmaceuticals by pharmaceutical companies. Promotion can be beneficial for society as a means of providing information, but it can also be harmful in the sense that it lowers price sensitivity of doctors and it merely is a means of establishing market share, even when cheaper, therapeutically equivalent drugs are available. A model is estimated that includes interactions of promotion expenditures and prices and that explicitly exploits the panel structure of the data, allowing for drug specific effects and dynamic adjustments, or habit persistence. The data used are aggregate monthly GP prescriptions per drug together with monthly outlays on drug promotion for the period 1994-1999 for 11 therapeutic markets, covering more than half of the total prescription drug market in the Netherlands. Identification of price effects is obtained by the introduction of the Pharmaceutical Prices Act, which established that Dutch drugs prices became a weighted average of the prices in surrounding countries after June 1996. We conclude that, on average, GP drug price sensitivity is small, but adversely affected by promotion.

JEL Classification: C23, D42, D61

Key words: drug price elasticity, promotion expenditures, panel data

Contents

Summary

Pharmaceutical companies spend large sums of money on the promotion of their products. In an absolute sense this is not surprising, since the pharmaceutical sector is very large: in 1996, 1.2% of GDP in industrialised countries was spent on pharmaceuticals. But pharmaceutical promotion outlays are large in a relative sense as well. In the entire economy, firms spend an average of 2% of their revenues on promotion. For pharmaceutical firms this percentage is much higher; estimates imply that around 15%-25% of their revenues are spent on promotion.

In many countries insurance or tax systems are in place such that the consumer of pharmaceutical products does not bear the full direct costs of pharmaceutical consumption. In the country under study in this paper, the Netherlands, the drugs prescribing decision is made by a general practitioner (GP) or specialist. The financial incentives for doctors to prescribe cheap drugs if they are available as an alternative are very weak. Together with a general insurance system, the price elasticity of demand for drugs is therefore expected to be small.

As physicians are the main decision-makers, most of pharmaceutical companies' promotion activities are directed to general practitioners and specialists. As large promotion outlays in a market with inelastic demand will lead to higher prices, it is important to assess the welfare aspects of pharmaceutical companies' marketing activities.

Promotion can have two effects on demand: it may shift the demand curve outwards as doctors prescribe more of the advertised drug and it may rotate the demand curve as demand becomes less or more price-elastic than before. In general, if product promotion lowers the price sensitivity, this will inhibit price competition and will lead to higher prices, thus harming social welfare. An outward shift of the demand curve for a drug could be socially desirable if this drug truly improves health at a reasonable cost. However, if promotion is merely a means of establishing market share, even when cheaper, therapeutically equivalent drugs are available, the promotion efforts may be socially harmful.

Using a unique data set that contains monthly information on demand, prices and promotion outlays for a large number of prescription drugs in the Netherlands during the years 1994-1999, a model is estimated to test whether promotion expenditures have an effect on the demand of pharmaceuticals.

Indeed, we find that promotion expenditures rotate the demand curve and adversely affect the own-price elasticity of drugs, reducing a potentially small negative price elasticity to almost zero. Thus the promotional expenditures make doctors less sensitive to prices when deciding which pharmaceutical should be described. Identification of the promotion effect on the price elasticity of demand is due to the introduction of the Pharmaceutical Prices Act, which established that Dutch drugs prices became a weighted average of the prices in the surrounding countries. This act came into effect in June 1996 and established that prices and promotion expenditures could no longer be set simultaneously by the drug producers.

We also find that promotion expenditures shift the demand curve outwards, indicating that a sizeable proportion of promotion efforts is about establishing or maintaining market share. A long run result we find is that if all companies increase total promotion outlays with 1% then total pharmaceutical consumption increases with about 0.2%. From this result we can, however, not conclude that the outward shift in the demand curve is socially harmful. To make such a conclusion we would need additional information, such as the optimum level of pharmaceutical consumption.

Our results are robust to alternative model specifications and the exclusion of new products from the analysis.

The first author, Frank Windmeijer, is affiliated with the Centre for Microdata Methods and Practice, Institute for Fiscal Studies, 7 Ridgmount Street, London WC1E 7AE, United Kingdom (email: f.windmeijer@ifs.org.uk).

The second author, Eric de Laat, was at the time of the research affiliated with the CPB, but is currently affiliated with the Ministry of Health, Welfare and Sports, Directorate GMT, P.O.Box 20350, 2500 EJ The Hague (email: ea.d.laat@minvws.nl).

The third and fourth author, Rudy Douven and Esther Mot, are affiliated with the CPB (email: r.douven@cpb.nl and e.mot@cpb.nl).

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1 Introduction

Pharmaceutical companies spend large sums of money on the promotion of their products. In an absolute sense this is not surprising, since the pharmaceutical sector is very large: in 1996, 1.2% of GDP in industrialised countries was spent on pharmaceuticals. But pharmaceutical promotion outlays are large in a relative sense as well. In the entire economy, firms spend an average of 2% of their revenues on promotion. For pharmaceutical firms this percentage is much higher: estimates imply that around 15%-25% of their revenues are spent on promotion (Jacobzone, 2000; Rosenthal et al. 2003; Scherer, 2000).

In many countries insurance or tax systems are in place such that the consumer of pharmaceutical products does not bear the full direct costs of drugs' consumption. In the country under study in this paper, the Netherlands, the drugs prescribing decision is made by a general practitioner (GP) or specialist. The financial incentives for doctors to prescribe cheap drugs if they are available as an alternative are very weak. Together with a general insurance system, the price elasticity of demand for drugs is therefore expected to be small.

As physicians are the main decision-makers and pharmaceutical promotion directed at consumers is not allowed in the Netherlands, most of pharmaceutical companies' promotion activities are directed to general practitioners and specialists. As large promotion outlays in a market with inelastic demand will lead to higher prices, it is important to assess the welfare aspects of pharmaceutical companies' marketing activities.[1] Using a unique data set that contains monthly information on demand, prices and promotion outlays for a large number of prescription drugs in the Netherlands during the years 1994-1999, a model is estimated based on the model as proposed by Rizzo (1999) in order to test whether promotion expenditure lowers the price sensitivity of demand for pharmaceutical products. In general, if product promotion lowers the price sensitivity, this will inhibit price competition and will lead to higher prices, thus harming social welfare.

To our knowledge, this question has only been addressed directly by Rizzo (1999) and Gönül et al. (2001), who arrive at opposite conclusions. Rizzo (1999) finds that promotion decreases the price elasticity in the market for anti-hypertensives in the US, whereas Gönül et al. (2001) find that promotion outlays can increase the price elasticity for drugs for an undisclosed specific therapeutic state. In the latter case promotion, on average, merely provides information about a product's characteristic and its price.

Our data characteristics differ from those of Rizzo (1999) and Gönül et al. (2001) in the following way. First of all, our data cover 11 therapeutic markets instead of one. Together these markets constitute more than 50% of the total Dutch prescription drug market, which makes it easier to formulate policy implications (see De Laat et al., 2002). Secondly, a major cause of price variation is the fact that in 1996 the Dutch government introduced a new law for the price

[1] See Hurwitz and Caves (1988), Rizzo (1999), Matraves (1999) and Scherer (2000) for good general discussions of the interactions between promotion expenditures, R&D and market structure in the pharmaceutical industry.

setting of prescription drugs. In June 1996, price caps were determined using neighbouring countries as references. This resulted in quite large exogenous decreases in drug prices of about 15% on average and large changes in relative prices. Price variation from June 1996 onwards mostly reflected exchange rate variation between the Netherlands and the UK. Thirdly, since Coscelli (2000) finds habit persistence to be an important attribute in these type of markets, the empirical model incorporates the possibility of habit persistence of patients and GPs by including past aggregate prescription behaviour.

The estimation results indicate that price sensitivity of general practitioners in the Netherlands is very small, but that promotion outlays did have a negative impact on the price responsiveness.

The outline of the paper is as follows. Section 2 reviews in detail the market for prescription drugs, describes which promotion activities are used by the pharmaceutical industry and discusses the various welfare aspects of promotion by pharmaceutical companies. Section 3 details the Dutch health care insurance system and prescription drugs' price setting. Section 4 presents the data and in Section 5 the empirical analysis is presented. Section 6 concludes.

2 Drugs Markets, Promotion Activities and Welfare Implications

Innovation and patenting play a central role in the supply of drugs. Price-cost margins for pharmaceutical manufacturers are high on average. Demand side characteristics such as intermediation by physicians, insurance coverage and low price elasticities interact with the presence of monopoly power on the supply side, due to patenting and brand loyalty, to support prices that commonly exceed drug production costs by a substantial margin. Among 459 four-digit manufacturing industries covered by the US census in 1987, pharmaceuticals had the sixth-highest price/cost margin at 61.4%. The average for all manufacturing industries was 30.5% (Scherer, 2000). According to Public Citizen (2001), Fortune magazine's rankings show that the pharmaceutical industry has been the most profitable in the USA in every year since 1982.

A justification for the high profitability of the pharmaceutical industry is generally believed to be the large risks associated with pharmaceutical R&D. An often cited number (based on a study by DiMasi et al., 1991) is that on average $500 million of R&D outlays are needed before one successful new drug can be marketed.[2]

It is important to note that there is not just one pharmaceutical market, but around a hundred different ones. Firms do not compete with each other within the total pharmaceutical market, but within therapeutic markets, defined by afflictions. Examples of such therapeutic markets are the markets for drugs against ulcers, hypertension and depression. Within these therapeutic markets substitutability of one product for another exists, but between such markets substitutability is low.

If there is competition between therapeutically substitutable drugs, the quality of the drug is an important decision factor. The quality of a drug is multi-faceted, the important characteristics are efficacy, safety, side effects and ease of use. In the early stages of the product life of a drug, when it is protected by a patent, its only competitors are drugs with different active ingredients. These therapeutic substitutes may differ in their efficacy, safety characteristics and side effects. After expiration of the patent, other producers can enter the market with generic copies of the drug. In general, prices of generic copies are lower than the branded precursor.

It is clear that there is an important role for promotion in the market for pharmaceuticals. Because another company may introduce a better drug and because the patent period is limited, the period to earn back the R&D (and other) investments is limited. Therefore, drug producers have to make sure that their products reach high sales levels as soon as possible.

Data on total promotion outlays by the pharmaceutical industry are scarce. Scherer (2000) reports that total prescription drug advertising and promotion outlays in the US market during 1997 were estimated to be $12 billion, or 18 percent of pharmaceutical sales. Rosenthal et al.

[2] In a report, Public Citizen (2001) brings this estimate down to $110 million.

(2003) report promotion to sales ratios of 13%-16% in the US during 1996-2000. Other available data represent marketing outlays, which are somewhat broader than promotion. In particular, distribution costs are typically included in marketing figures. OECD figures (Jacobzone, 2000) show that in 1989 research-oriented drug firms spent 24% of sales on marketing. This makes the pharmaceutical industry one of the biggest spenders on promotion. In contrast, these firms spent 13% of sales on R&D.

Pharmaceutical companies use many instruments to influence the prescribing decisions made by general practitioners. Of these, detailing (where a representative of the company pays a visit to the GP) is the most important way of communicating with and informing GPs about a drug's performance. Other promotion activities aimed at GPs are advertising in medical journals, direct mail, so-called post marketing research (PMR) programs and continuing medical education (CME) events.

Promotion can have two effects on demand: it may shift the demand curve outwards as doctors prescribe more of the advertised drug and/or it may rotate the demand curve as demand becomes less or more price-elastic than before. In general, if product promotion lowers the price sensitivity, this will inhibit price competition and will lead to higher prices, thus harming social welfare. An outward shift of the demand curve for a drug could be socially desirable if this drug truly improves health at a reasonable cost. However, if promotion is merely a means of establishing market share, even when cheaper, therapeutically equivalent drugs are available, the promotion efforts may be socially harmful.

3 The Dutch Health Care System and Drugs Price Setting

The Dutch health care system is a mixture of public and private funding. At the individual level, a person is covered by and contributes directly to public insurance when her income is below a certain threshold. Above the threshold, an individual can choose to obtain cover from a private insurer, which practically all private insured persons do.
The Dutch pharmaceutical reimbursement system clusters products into small groups of close substitutes. The maximum reimbursement price within a group is a weighted average of the prices of the products in the group at some baseline date. Patients who receive prescriptions for products with a price exceeding its limit have to pay the difference out-of-pocket. Products without close substitutes (typically new products) are not clustered and do not have a maximum reimbursement price. Upon introduction of the system in 1991 most product prices in excess of the limit were lowered to this limit. The same happened in 1999 when the limits were recalculated with new baseline prices. As a result, the amount of co-payment is very low: 0.6% in 2000. More than 40% of these co-payments were for hormonal contraceptives (GIP/CVZ, 2002).

During the period over which we have data (1994-1999), there have been some major price reforms in the Netherlands. The most important one was the Pharmaceutical Prices Act that came into effect in June 1996. From then, the maximum price for a drug was established as an average of the prices of the drug in Germany, France, UK, and Belgium. As drug prices were traditionally quite high in the Netherlands as compared to the surrounding countries, the Pharmaceutical Prices Act resulted in considerably lower drug prices in general (on average by about 15%). Prices of products without a reimbursement price were affected the most by the new act, but also many clustered products (including generics) were forced to lower their prices. An important driver for exogenous price fluctuations after the introduction of the Pharmaceutical Prices Act is the British Pound - Dutch Guilder exchange rate. The relative weight of the UK then determines the relative price fluctuations of drugs within a market.

4 Data

The monthly data on prescriptions by GPs and associated costs were obtained from the Health Insurance Board.[3] The data are taken from 9 public insurance funds and extrapolated to cover the whole of the Netherlands. From IMS Health, promotion expenditure per drug has been obtained.[4] The promotion expenditure is subdivided into three categories: detailing, advertising and direct mail. Within this total, these three groups account for approximately 63%, 25% and 12% of marketing expenditure respectively. Not all promotion activities by pharmaceutical firms are included in the data. Promotion activities related to courses, sponsorships, promotion events, opinion leaders etc. are not included in our dataset.

Markets

The data collected were for drugs in the following 11 therapeutic markets: pharmaceuticals against hypertension, ulcers, cholesterol, pregnancy (oral contraceptives), depression,[5] rheumatism, migraine, anxiety, asthma, sleeping disorders and allergies. Together these markets account for 58% of the total prescription drugs market in terms of market value, and 55% in terms of the promotion expenditures in the IMS Health database.

Demand is measured in Defined Daily Doses (DDD), which is a standard measure determined by the World Health Organization that indicates the typical daily dosage of a drug for standard treatment.

A common feature of drug markets is that of parallel importing, where branded drugs get imported from countries with lower (regulated) prices. Total demand of branded products includes parallel importing, and prices are weighted averages. In general, prices per DDD are the ratio of total cost to total number of DDDs prescribed per month.

A Graphical Analysis

Before we turn to the empirical analysis to address the central question of this paper, we examine the data regarding some general, descriptive issues. We focus on the markets of anti-hypertensives, anti-ulcer drugs, cholesterol lowering drugs and anti-depressants. The first two markets are the largest in size in terms of sales (in each market around 290 million euros in 1999) whereas cholesterol medication is a large market (around 180 million euros in 1999) which has had the largest growth rate over the period. The market for anti-depressants is smaller (around 115 million euros in December 1999),[6] but spending on the observed marketing

[3] Genees- en hulpmiddelen Informatie Project / College voor Zorgverzekeringen, Diemen.

[4] Medische Promotie Index, IMS HEALTH Nederland b.v., the Hague. Note that not all promotion activities by pharmaceutical firms are included in the data. Promotion activities related to courses, sponsorships, promotion events, opinion leaders etc. are not included in the dataset.

[5] The data on anti-depressants and anxiety drugs were collected from February 1995 onwards.

[6] For more descriptive statistics, see De Laat et. al. (2002).

activities is high in this market: in the observation period on average 6.5% of sales with a maximum of 12%.

Figures 1-4 show the movements of the average prices for the four markets over time. It is clear that the Pharmaceutical Prices Act that came into effect in June 1996, and is highlighted by a vertical line in the graphs, lowered the prices considerably in most cases. Note that the high average prices for anti-ulcer drugs at the end of the period are due to the introduction of Pantopac, which is quite expensive.

Figures 5-8 depict market sizes over time in DDDs. All four markets expanded quite considerably during the period with the largest growth rate for cholesterol lowering drugs (annually 45% on average).

Figures 9-12 show the ratios of total promotion expenditures to total sales for branded drugs in these markets. For the anti-ulcer drug market, the extra marketing expenditure due to the introduction of Pantopac in the last eight months of the observation period can be clearly observed. Similarly, for the cholesterol market, the increase in the promotion to sales ratio in October 1995 is due to the introduction of Lescol. The promotion to sales ratio is high for anti-depressants at the beginning of the period, almost 12 %, but declines gradually over the period to about 4% at the end.

How important are generic drugs? Figures 13-16 show the market shares of branded products versus generic drugs. Apart from the cholesterol market, generic drugs have increased their market shares over time. The steep increase in the market share of generics in the market for anti-hypertensive drugs between July 1996 and April 1997 is due to the introduction of the generic ACE inhibitor captopril that challenged the position of the name-brand Capoten. In January 1999 another generic anti-hypertensive drug was brought to market, bumetanide.

Figures 17 and 18 display the demand and prices for the anti-ulcer drug Zantac and the generic Ranitidine, which is responsible for the large increase in market share of generic drugs in the market for anti-ulcer drugs. The price difference between the two drugs is actually quite small.[7] Figures 19 and 20 show a different picture for Adalat, a pharmaceutical against hypertension, which had generic competition throughout the period. This name-brand drug kept its market share relative to the generic even though the price of the generic was lower.

[7] This small price differential between name-brand and generic is typical for the Dutch prescription drug market. Generic producers keep consumer prices high to offer high margins to pharmacists, who are the decision makers regarding which generic is delivered. A pharmacist can supply a generic if the GP does not specifically prescribe the name-brand drug.

5 Empirical Analysis

In order to estimate the effects of promotion expenditures on physicians' prescribing behaviour and especially their impact on GP's price sensitivity, a model is estimated that is similar in spirit to that proposed by Rizzo (1999) and specified as:

$$\begin{aligned}\ln q_{it} = {} & \rho_1 \ln q_{i,t-1} + \rho_2 \ln q_{i,t-2} + \\ & + (\alpha_1 + \alpha_2 \ln proms_{it}) \times \ln p_{it} + \alpha_3 \ln promf_{it} + \alpha_4 \ln proms_{it} \\ & + (\alpha_5 + \alpha_6 \ln proms_{it}) \times \ln pc_{itj} + \alpha_7 \ln promfc_{itj} + \alpha_8 \ln promsc_{itj} \\ & + x'_{it}\beta + \gamma_i + \varepsilon_{it}\end{aligned}$$

where q_{it} is demand measured in DDDs for drug i, $i = 1,\ldots, N$, in month t, $t = 1,\ldots, T$; p_{it} is the price of drug i in month t; $promf_{it}$ is the monthly promotion expenditure; $proms_{it}$ is the stock of promotion expenditure (to capture delayed effects of promotion, see below); pc_{itj} is the average price of competing drugs in market j, where markets are defined by ATC3 codes;[8] $promfc_{itj}$ and $promsc_{itj}$ are the promotion expenditures for competing drugs; x_{it} contains several auxiliary variables, including drug specific characteristics, like age, but also year and month indicators. The γ_i are drug specific intercepts that will control for unobservable perceived quality differences between drugs that are constant over time. It is important to allow for this type of quality effects, as it is likely that prices and quality are correlated.

The interaction between the drug's own price and promotion expenditures enables one to test for the effect of promotion expenditure on price elasticity. If $\alpha_2 > 0$ ($\alpha_6 < 0$), then promotion adversely affects the own (cross) price elasticity of a drug, provided that reverse causation can be ruled out. After all, it may well be the case that α_2 is larger than zero because advertising expenditure can be more profitable for drugs that are relatively price inelastic, as a monopolist sets price and promotion expenditure simultaneously, see Dorfman and Steiner (1954). In addition to robustness checks we performed to rule out reverse causation, the introduction of the Pharmaceutical Prices Act helps to identify the promotion effect, as the price setting for the Netherlands no longer reflects the price elasticity/promotion expenditure tradeoff of the monopolist. Not only is it likely that price elasticities for drugs are different in the Netherlands than in the surrounding countries (drug consumption per capita has historically been much lower in the Netherlands), the UK, for example, imposes restrictions on price setting and promotion via the Pharmaceutical Price Regulation Scheme. The result of this policy feeds through into the Dutch prices by the Pharmaceutical Prices Act. Further, most of the price

[8] ATC stands for Anatomic Therapeutic Chemical. Each drug is classified by its ATC3, ATC4 and ATC5 codes. For example, within the class of anti-hypertensive drugs, the ATC3 codes C09A and C09B constitute the ACE inhibitors. The ATC4 codes C09AA, C09BA and C09BB are the ACE inhibitors proper, ACE inhibitors in combination with diuretics, and ACE inhibitors in combination with calcium channel antagonists, respectively. Finally, the ATC5 code defines the molecule, for example C09AA01 is captopril.

variation after the introduction of the Pharmaceutical Prices Act is due to fluctuations in the exchange rate between the British Pound and the Dutch Guilder, which is an exogenous variation.

A difference with the model of Rizzo (1999) is the fact that lags of the dependent variable are included in the model. These take account of the fact that there may be habit persistence/brand loyalty among GPs, or that it is for example not easy to change repeat prescriptions immediately after a price change or a promotion expenditure increase for an alternative drug. Further, we have included an interaction of $\ln pc$ and $\ln proms$ to allow for promotion expenditure to affect the cross-price elasticity.

A second difference with Rizzo's model is the way the initial stock of promotion expenditures is constructed. Both Rizzo's and our model defines the promotion stock as:

$$proms_{it} = (1-\delta_m)\, proms_{i,t-1} + promf_{it},$$

where δ_m is the monthly depreciation rate of promotion expenditure. The problem with this construction of the stock variable is that most products covered in the data set are already in existence when the observation period starts in January 1994, and promotion expenditures prior to 1994 are not known to us. For these products we need to construct an initial stock of promotion expenditures. Rizzo (1999) constructed the initial promotion expenditure stock by assuming that promotion expenditures in the years prior to observation are the same as in the first year of observation. As the life-cycle pattern of promotion expenditures for drugs shows that more promotion expenditure is done at the introduction of a drug than later in its life, see Figure 21, this procedure is likely to underestimate the initial promotion expenditure stock. We therefore estimate the simple model

$$promf_{iy} = \theta_{i0} + \theta_1 age_{iy} + v_{iy},$$

where $promf_{iy}$ is the promotion expenditure for drug i in year y, and age_{iy} is the age of the drug in years. We then use the estimates of this model to estimate the initial stock of promotion expenditure, calibrating the drug specific intercept in such a way that the promotion expenditures in the first year of observation are predicted exactly.[9]

[9] The initial stock of promotion expenditure is estimated as $\hat{proms}_{i,12/1993} = \sum_{j=0}^{age_{i,1994}-1} \hat{promf}_{i,1993-j}(1-\delta_y)^j$; $\hat{promf}_{iy} = \hat{\tau}_i + \hat{\theta}_1 age_{iy}$, $\hat{\tau}_i = promf_{i,1994} - \hat{\theta}_1 age_{i,1994}$, $\hat{\theta}_1 = -34047$ $(se = 4652)$ where $\hat{proms}_{i,12/1993}$ is the estimated stock of promotion expenditure in December 1993, and δ_y is the annual depreciation rate of promotion expenditures, estimation of which is discussed below.

Estimation Results

The model is estimated on a sub-sample of drugs that did not experience generic competition.[10] If generic competition was introduced during the observation period, only the pre-generic competition period for the drug is included in the sample. This is done because market conditions for drugs that experience generic competition are completely different from those that do not, as was made clear in the graphical analysis in Section 4.

Table 1 presents OLS estimation results. The sample consists of 140 branded drugs, with a total of 7044 observations, as the panel is unbalanced. Variables that are further included in the model but that are not presented in the tables are drug specific dummies, year and month dummies,[11] dummies for the period of the Pharmaceutical Prices Act and two further differing, more minor, price regimes, a dummy measuring whether a drug required co-payment, and if so the log of the amount of co-payment.[12] All variables that are measured in logs were set equal to zero when their levels were equal to zero, and dummies were included when this was the case. The annual discount rate for promotion expenditure δ_y, with its associated monthly rate δ_m, is obtained by minimising the residual sum of squares by means of a grid search using multiples of 0.05.

The first two columns of Table 1 present the results of the model that does not include interactions of promotion expenditures and prices. It is clear that the prescription drugs series are quite persistent with the coefficients on lagged prescriptions summing up to 0.82.[13] This means that there is a strong habit persistence/brand loyalty, and that any changes due to changing prices and/or changing promotion efforts take some time to be fully established. The estimated coefficients on own and competitor's prices are the short run elasticities and are found to be not significantly different from zero. The stock of promotion expenditures has a positive effect on demand, whereas competitor's promotion efforts have a negative effect. The promotion expenditure annual depreciation rate δ_y is found to be 0.55.

Table 2 presents the long-run, steady state elasticities in response to permanent changes. The steady state own price elasticity in the model without interactions is given by $\alpha_1/(1-\rho_1-\rho_2)$. The steady-state own promotion expenditure in this model is given by $(\alpha_3+\alpha_4)/(1-\rho_1-\rho_2)$ as a steady-state permanent 1% increase in $promf$ results in a permanent 1% increase in $proms$. The long-run own- and cross price elasticities are not significantly different from zero. The own promotion effect is 0.30 (s.e. 0.03), whereas the competitors' promotion effect is –0.12

[10] For some drugs, the price variation was unrealistically volatile, probably due to measurement error. These drugs are removed from the analysis.

[11] Due to the very distinct seasonal pattern of anti-allergy drugs, separate month dummies were estimated for these drugs.

[12] As mentioned in Section 3, co-payments are uncommon: for the vast majority of drugs no co-payment is required. Co-payments constitute only 0.6% of total drug costs in 2000, with more than 40% concentrated in one specific market, hormonal contraceptives (GIP/CVZ, 2002). Therefore data on co-payments alone could not be used to estimate price elasticities.

[13] Two lags of the dependent variable in the model proved to be sufficient to capture this effect: the model residuals do not display any further within drug autocorrelation.

(s.e. 0.04), indicating that a sizeable proportion of promotion efforts is about establishing or maintaining market share.

From the results for the model with interactions, as presented in columns 3 and 4 in Table 1, it is clear that price elasticities are adversely affected by promotion expenditures, as $\alpha_2 > 0$ and $\alpha_6 < 0$. For the model with interactions between prices and the stock of promotion expenditures, steady-state own price elasticities are reported at various quantiles of the distribution of $\ln proms$ in Table 2. It is – 0.26 at the 5th percentile of $\ln proms$, 0.12 at the median and 0.29 at the 95th percentile. Although these elasticities are estimated quite imprecisely, the gradient of the own-price elasticity is apparent. Estimates for the steady-state interaction terms $\alpha_2/(1-\rho_1-\rho_2)$ and $\alpha_6/(1-\rho_1-\rho_2)$ are given by 0.088 (s.e. 0.031) and – 0.055 (s.e. 0.033) respectively.

Robustness

These findings are robust to allowing for separate levels of price elasticity per ATC3 group of drugs. The model was re-estimated with interactions between $\ln p$ (and $\ln pc$) and ATC3 classification dummies. Rizzo (1999) motivated this model for dealing with the Dorfman-Steiner problem of joint determination of prices and promotion expenditures. Estimates for the steady-state interaction terms in this case are given by 0.105 (s.e. 0.038) and – 0.055 (s.e. 0.037).

Prices and promotion expenditures can be endogenously determined with respect to demand shocks at this aggregate level. The model was re-estimated by instrumental variables using lagged prices and promotion expenditures as instruments. The estimation results using this IV procedure were very similar to those as reported in Table 1 and are therefore not reported here. A Hausman test did not reject the null hypotheisis of exogeneity of the regressors (p-value 0.38).

The model has also been estimated for the 11 markets separately. Not all markets display the same promotion expenditure effects as found for the pooled sample. Tables 3 and 4 show the results for the Anti-Hypertension, Anti-Ulcer, Cholesterol and Anti-Depressant markets.[14] The results for the Anti-Hypertension, Anti-Ulcer and Cholesterol markets are broadly similar to those of the pooled sample, especially with respect to the signs of α_2 and α_6. For the market of Anti-Depressants, promotion expenditures seem to have the effect of increasing the price sensitivity of GPs. However, a simple F-test for testing whether all parameters are the same in the 11 markets has a value of 0.1782, clearly not rejecting the null hypothesis and thus the pooled results.

[14] Keeping the value of the depreciation rate the same across markets as estimated in Table 1.

The estimation results as presented in Tables 1 and 2 were for branded products without generic competition, including products that appeared new on the market during our sample period. To check whether these new products, with relatively large promotion expenditures, had a disproportionate effect on our findings, Tables 5 and 6 present estimation results when the demand series for new products that enter the market during 1994-1999 are deleted from the analysis.[15] The sample size is now considerably smaller with 5342 observations for 86 drugs. The annual depreciation rate for promotion expenditures is estimated as 0.45 for this sample, smaller than for the sample including new products where it was estimated as 0.55, indicating that the stock of promotion expenditures depreciates faster for new products. For the model without interactions, the steady-state own price elasticity is – 0.31 (s.e. 0.27) for this group of drugs, with the cross-price elasticity being 0.14 (s.e. 0.26). So, although the standard errors are quite large, the price sensitivity seems higher as compared to the sample with new products included. The steady-state own promotion elasticity is 0.39 (s.e. 0.05), whereas the competitors' promotion elasticity is – 0.09 (s.e. 0.07). When prices and promotion expenditures are interacted, the estimates for the steady-state promotion effect on the own-price elasticity, $\alpha_2/(1-\rho_1-\rho_2)$, is given by 0.098 (s.e. 0.048) which is again very similar to that found before. The promotion effect on the cross price elasticity is not significantly different from 0, $\alpha_6/(1-\rho_1-\rho_2)$ is estimated as –0.022 (s.e. 0.052). For the model with interactions between prices and the stock of promotion expenditures, steady-state own price elasticities are again reported at various quantiles of the distribution of $\ln proms$ in Table 6. It is – 0.60 at the 5th percentile of $\ln proms$, – 0.30 at the median and – 0.10 at the 95th percentile.

Table 7 finally presents estimation results for the two samples for a more flexible functional form regression model. This model includes interactions between prices and age and age-squared to allow for different life cycle price elasticities and further includes a quadratic term in the log of the stock of own promotion expenditure. The estimation results indicate that demand for products gets less price sensitive at first with age and then more price sensitive when they get older, the turning point at around 20 months in the sample with new products. The inclusion of the quadratic term in the log of the stock of own promotion expenditure show that there is a decreasing increase in the marginal return to own promotion expenditures. Again, for both samples, the own price elasticity is smaller for larger promotion expenditures, the interaction term α_2 estimated as 0.021 (se 0.009) and 0.021 (se 0.013) for the sample with and without new products respectively.

[15] The marketing expenditures for new products are still part of promfc and promsc.

6 Conclusions

Using an extension of the model as proposed by Rizzo (1999), we have established that promotion expenditures adversely affect the own-price elasticity of drugs, reducing a potentially small negative price elasticity to almost zero. The analysis has used data for a large group of drugs from different markets. Identification of the promotion effect on the price elasticity of demand is due to the introduction of the Pharmaceutical Prices Act, which established that Dutch drugs prices became a weighted average of the prices in the surrounding countries. This act came into effect in June 1996 and established that prices and promotion expenditures could no longer be set simultaneously by the drug producers.

When considering demand for brand-name drugs for which there are no generic alternatives, we find a positive effect of promotion expenditure on the own-price elasticity (i.e. smaller price-sensitivity) and a negative effect on the cross-price elasticity, a result that is robust to alternative model specifications and the exclusion of new products from the analysis.

Our results also show that promotion expenditures shift the demand curve outwards, indicating that a sizeable proportion of promotion efforts is about establishing market share. A long run result we find is that if all companies increase total promotion outlays with 1% then total pharmaceutical consumption increases with about 0.2%. From this result we can, however, not conclude that the outward shift in the demand curve is socially beneficial or not. To draw such a conclusion we would need additional information, such as the optimum level of pharmaceutical consumption.

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Annex

Table 1 Estimation Results, OLS within groups, no generic equivalent

	Coeff	Se	Coef	Se
$\ln q_{-1}$	0.6797	0.0552	0.6759	0.0554
$\ln q_{-2}$	0.1404	0.0460	0.1390	0.0459
$\ln p$	0.0109	0.0287	– 0.1816	0.0929
$\ln p \times \ln proms$			0.0161	0.0064
$\ln promf$	0.0151	0.0044	0.0137	0.0046
$\ln proms$	0.0386	0.0101	0.0403	0.0106
$\ln pc$	0.0002	0.0309	0.1048	0.0729
$\ln pc \times \ln proms$			– 0.0102	0.0055
$\ln promfc$	0.0128	0.0039	0.0122	0.0040
$\ln promsc$	– 0.0337	0.0073	– 0.0298	0.0071
$age_m^2 /100$	– 0.0194	0.0068	– 0.0226	0.0073
$\delta_y = 0.55$				
$\delta_m = 0.0644$				
R^2		0.8701		0.8705
# obs				7040
# drugs				140

Variables that are further included in the model but that are not presented in the table are drug specific dummies, year and month dummies, dummies for the period of the Pharmaceutical Prices Act and two further differing, more minor, price regimes, a dummy measuring whether a drug required co-payment, and if so the log of the amount of co-payment.
Reported standard errors are robust to general form of heteroskedasticity.

Table 2 Steady-State Elasticities, OLS within groups, no generic alternative

	No interactions		Interactions	
	Coeff	Se	Coeff	Se
p	0.0611	0.1626		
p(ln *proms*5)			– 0.2612	0.2342
p(ln *proms*25)			– 0.0328	0.1800
p(ln *proms*50)			0.1243	0.1612
p(ln *proms*75)			0.2167	0.1602
p(ln *proms*95)			0.2869	0.1647
promf	0.2991	0.0296		
promf (ln *proms*5)			0.1629	0.0582
promf (ln *proms*25)			0.2808	0.0290
promf (ln *proms*50)			0.3197	0.0302
promf (ln *proms*75)			0.3556	0.0371
promf (ln *proms*95)			0.4137	0.0543
pc	0.0013	0.1719		
pc(ln *proms*5)			0.1109	0.2138
pc(ln *proms*25)			– 0.0334	0.1855
pc(ln *proms*50)			– 0.1328	0.1867
pc(ln *proms*75)			– 0.1912	0.1955
pc(ln *proms*95)			– 0.2355	0.2057
promfc	– 0.1161	0.0370	– 0.0955	0.0367

The steady state elasticities are presented for various quantiles of promotion. In the lower quantiles drugs are considered with low (or no) promotion efforts, whereas higher quantiles include drugs with higher promotion efforts.

Table 3 Estimation Results, OLS within groups, no generic equivalent

	Anti-Hypertension		Anti-Ulcer	
	Coeff	Se	Coeff	Se
$\ln q_{-1}$	0.6503	0.1006	0.4562	0.0676
$\ln q_{-2}$	0.1950	0.0803	0.1916	0.0825
$\ln p$	– 0.4632	0.3526	– 0.8966	0.6426
$\ln p \times \ln proms$	0.0389	0.0242	0.0677	0.0543
$\ln promf$	0.0122	0.0118	0.0060	0.0121
$\ln proms$	0.0268	0.0200	0.1459	0.0609
$\ln pc$	0.9718	0.2231	0.3979	0.4286
$\ln pc \times \ln proms$	– 0.0600	0.0166	– 0.0302	0.0319
$\ln promfc$	0.0225	0.0112	0.0512	0.0376
$\ln promsc$	– 0.0319	0.0137	– 0.8751	0.1893
$age_m^2 / 100$	0.0186	0.0259	0.0256	0.0539
R^2		0.9879		0.9946
# obs		2266		648
# drugs		46		13

Variables that are further included in the model but that are not presented in the table are drug specific dummies, year and month dummies, dummies for the period of the Pharmaceutical Prices Act and two further differing, more minor, price regimes, a dummy measuring whether a drug required co-payment, and if so the log of the amount of co-payment.
Reported standard errors are robust to general form of heteroskedasticity.

Table 4 Estimation Results, OLS within groups, no generic equivalent

	Cholesterol		Anti-Depressants	
	Coeff	Se	Coeff	Se
$\ln q_{-1}$	0.5369	0.0928	0.8444	0.1167
$\ln q_{-2}$	0.1693	0.1118	0.0114	0.1200
$\ln p$	0.0907	0.4660	0.3650	0.1585
$\ln p \times \ln proms$	– 0.0087	0.0368	– 0.0257	0.0121
$\ln promf$	– 0.0078	0.0099	0.0502	0.0099
$\ln proms$	0.1553	0.0469	0.0661	0.0195
$\ln pc$	0.7687	0.7972	– 0.5596	0.5888
$\ln pc \times \ln proms$	– 0.0816	0.0551	0.0209	0.0406
$\ln promfc$	– 0.0080	0.0178	0.1415	0.0260
$\ln promsc$	0.1372	0.0872	0.1044	0.1964
$age_m^2 /100$	– 0.1226	0.0646	0.0623	0.0186
R^2		0.9954		0.9958
# obs		515		642
# drugs		10		14

Variables that are further included in the model but that are not presented in the table are drug specific dummies, year and month dummies, dummies for the period of the Pharmaceutical Prices Act and two further differing, more minor, price regimes, a dummy measuring whether a drug required co-payment, and if so the log of the amount of co-payment.
Reported standard errors are robust to general form of heteroskedasticity.

Table 5 Estimation Results, OLS within groups, no generic equivalent, no new products

	Coeff	Se	Coeff	Se
$\ln q_{-1}$	0.4393	0.0600	0.4375	0.0600
$\ln q_{-2}$	0.4394	0.0611	0.4373	0.0612
$\ln p$	– 0.0375	0.0333	– 0.1924	0.1107
$\ln p \times \ln proms$			0.0122	0.0071
$\ln promf$	0.0070	0.0026	0.0060	0.0028
$\ln proms$	0.0396	0.0110	0.0431	0.0117
$\ln pc$	0.0168	0.0322	0.0325	0.0755
$\ln pc \times \ln proms$			– 0.0027	0.0055
$\ln promfc$	0.0126	0.0037	0.0120	0.0036
$\ln promsc$	– 0.0230	0.0084	– 0.0161	0.0078
$age_m^2 / 100$	0.0015	0.0060	– 0.0018	0.0064
$\delta_y = 0.45$				
$\delta_m = 0.0486$				
R^2		0.8362		0.8365
# obs				5342
# drugs				86

Variables that are further included in the model but that are not presented in the table are drug specific dummies, year and month dummies, dummies for the period of the Pharmaceutical Prices Act and two further differing, more minor, price regimes, a dummy measuring whether a drug required co-payment, and if so the log of the amount of co-payment.
Reported standard errors are robust to general form of heteroskedasticity.

Table 6 Steady-State Elasticities, OLS within groups, no generic alternative, no new products

	No interactions		Interactions	
	Coeff	Se	Coeff	Se
p	– 0.3098	0.2687		
p(ln *proms*5)			– 0.6024	0.3731
p(ln *proms*25)			– 0.4394	0.3016
p(ln *proms*50)			– 0.3026	0.2548
p(ln *proms*75)			– 0.1854	0.2304
p(ln *proms*95)			– 0.0976	0.2250
promf	0.3853	0.0478		
promf (ln *proms*5)			0.2303	0.0938
promf (ln *proms*25)			0.3653	0.0452
promf (ln *proms*50)			0.4122	0.0520
promf (ln *proms*75)			0.4612	0.0711
promf (ln *proms*95)			0.5285	0.1051
pc	0.1393	0.2578		
pc(ln *proms*5)			0.0468	0.3024
pc(ln *proms*25)			0.0097	0.2856
pc(ln *proms*50)			– 0.0214	0.2869
pc(ln *proms*75)			– 0.0481	0.2992
pc(ln *proms*95)			– 0.0681	0.3145
promfc	– 0.0862	0.0654	– 0.0326	0.0608

The steady state elasticities are presented for various quantiles of promotion. In the lower quantiles drugs are considered with low (or no) promotion efforts, whereas higher quantiles include drugs with higher promotion efforts.

Table 7 Estimation Results, OLS within groups, no generic equivalent

	With new products		Without new products	
	Coeff	Se	Coeff	Se
$\ln q_{-1}$	0.6704	0.0553	0.4339	0.0599
$\ln q_{-2}$	0.1446	0.0457	0.4369	0.0612
$\ln p$	– 0.2831	0.1444	– 0.3627	0.2153
$\ln p \times \ln proms$	0.0206	0.0092	0.0214	0.0133
$\ln promf$	0.0210	0.0053	0.0108	0.0027
$\ln proms$	0.2420	0.0364	0.2420	0.0655
$(\ln proms)^2$	– 0.0091	0.0017	– 0.0084	0.0024
$\ln pc$	0.0054	0.0839	– 0.0509	0.0934
$\ln pc \times \ln proms$	– 0.0040	0.0059	0.0024	0.0064
$\ln promfc$	0.0128	0.0039	0.0124	0.0036
$\ln promsc$	– 0.0306	0.0084	– 0.0183	0.0107
$age_m^2 /100$	– 0.0171	0.0107	0.0026	0.0107
$\ln p \times age_m /10$	0.0902	0.0268	0.0737	0.0255
$\ln p \times age_m^2 /100$	– 0.0225	0.0077	– 0.0141	0.0073
δ_y		0.50		0.40
δ_m		0.0561		0.0417
R^2		0.8714		0.8372
# obs		7040		5342
# drugs		140		86

Variables that are further included in the model but that are not presented in the table are drug specific dummies, year and month dummies, dummies for the period of the Pharmaceutical Prices Act and two further differing, more minor, price regimes, a dummy measuring whether a drug required co-payment, and if so the log of the amount of co-payment.
Reported standard errors are robust to general form of heteroskedasticity.

Figure 1 **Average prices (in Dfl=0,45 euro) per DDD, Anti-hypertension**

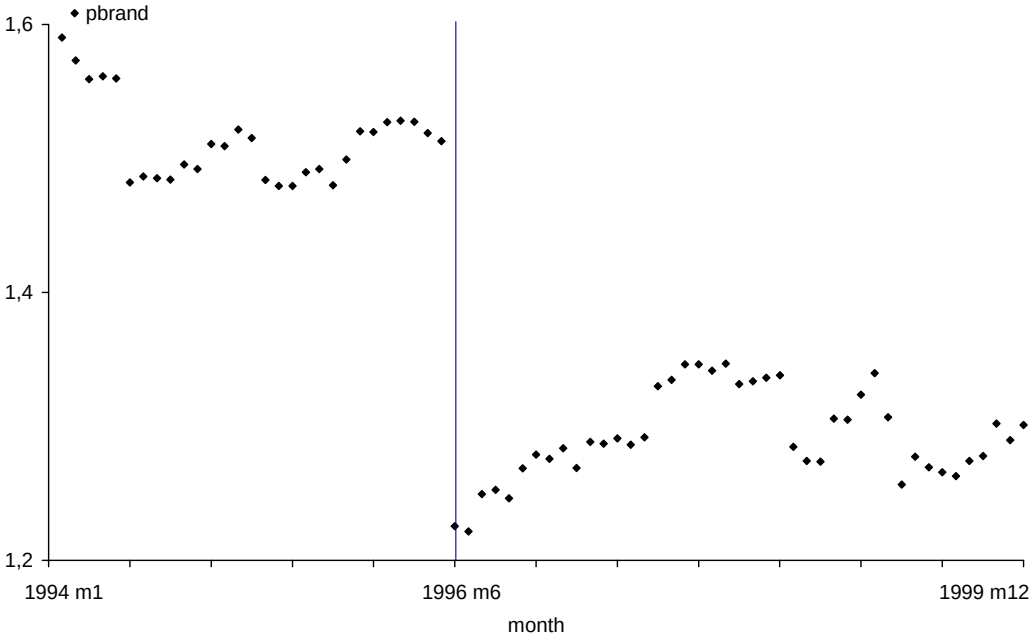

Figure 2 **Average prices (in Dfl=0,45 euro) per DDD, Anti-ulcer**

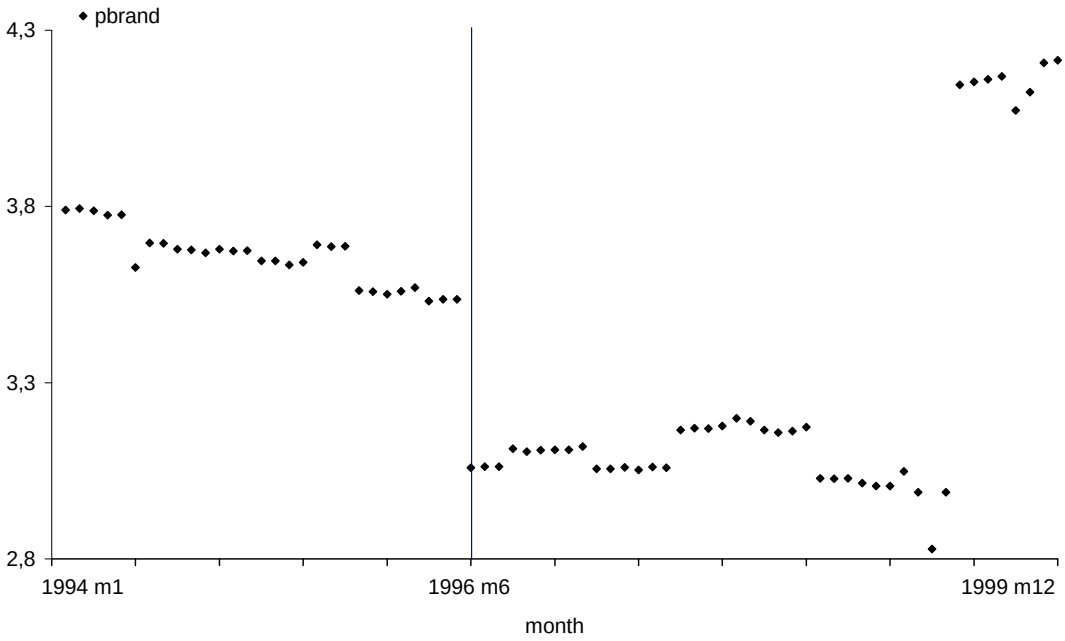

Figure 3 **Average prices (in Dfl=0,45 euro) per DDD, Cholesterol**

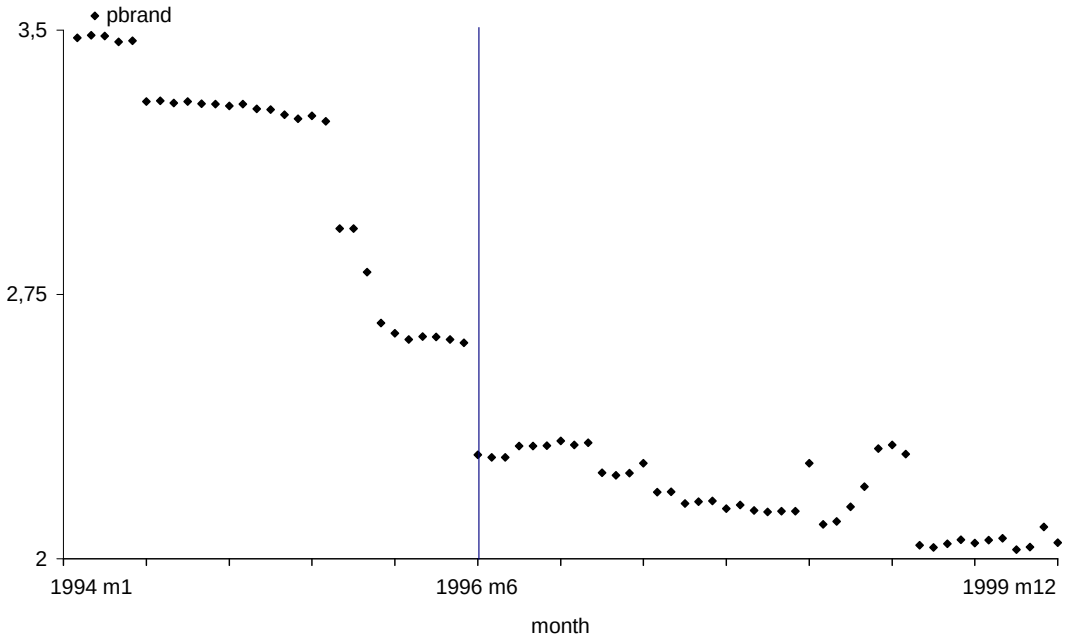

Figure 4 **Average prices (in Dfl=0,45 euro) per DDD, Anti-depressants**

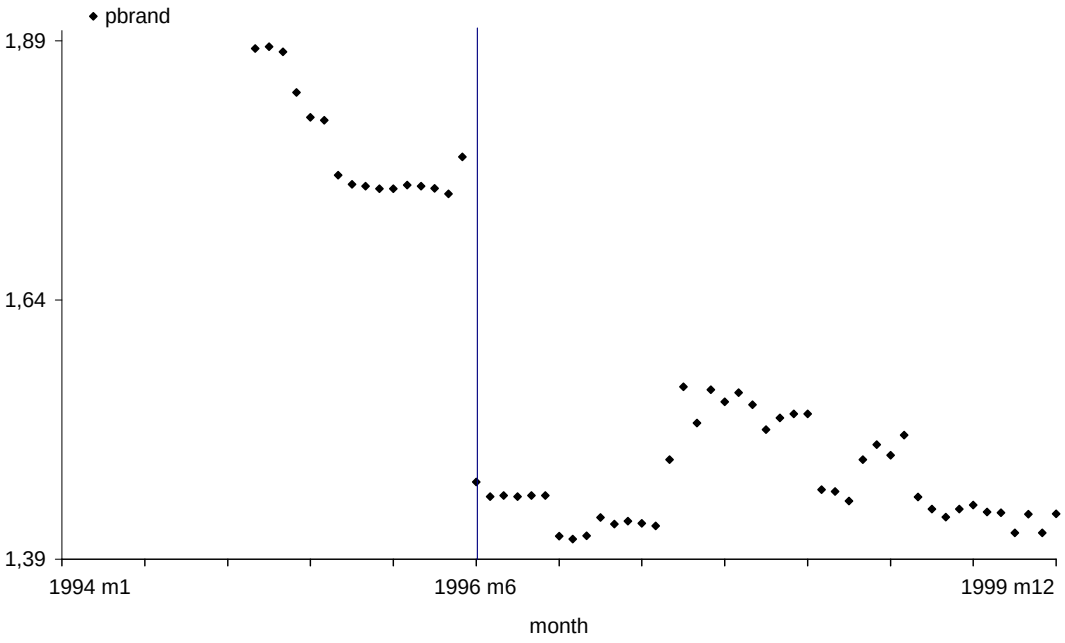

Figure 5 **Market size in million DDD's, Anti-hypertension**

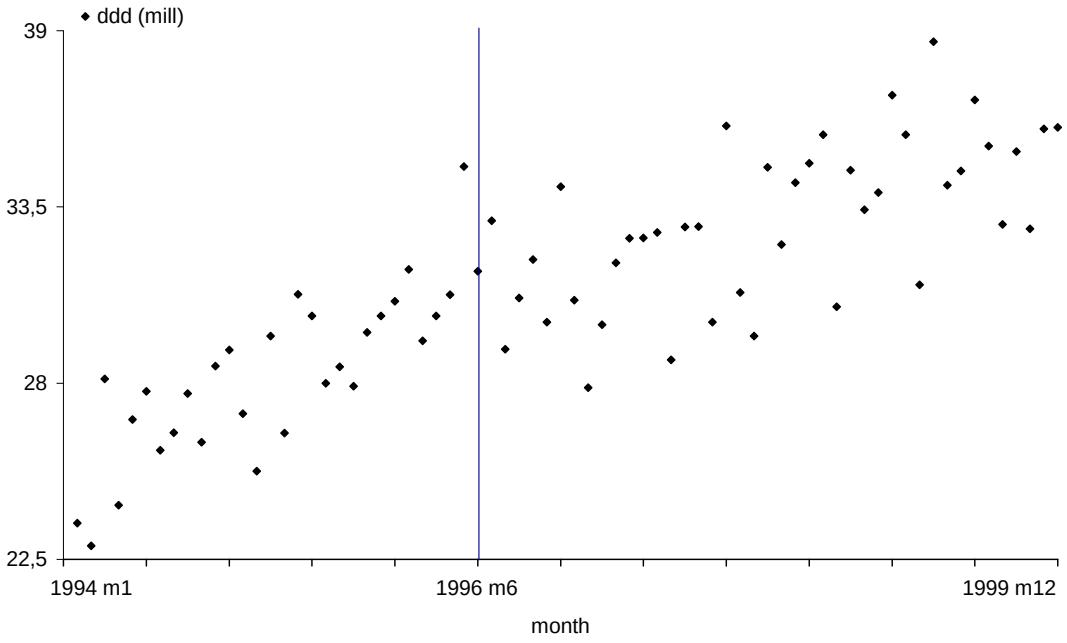

Figure 6 **Market size in million DDD's, Anti-ulcer**

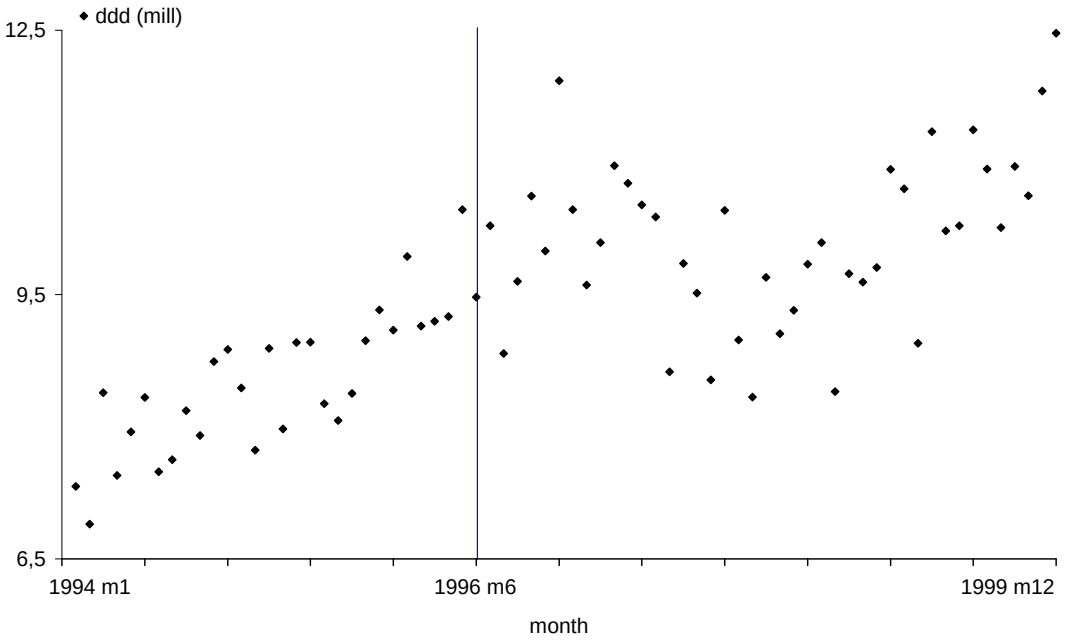

Figure 7 **Market size in million DDD's, Cholesterol**

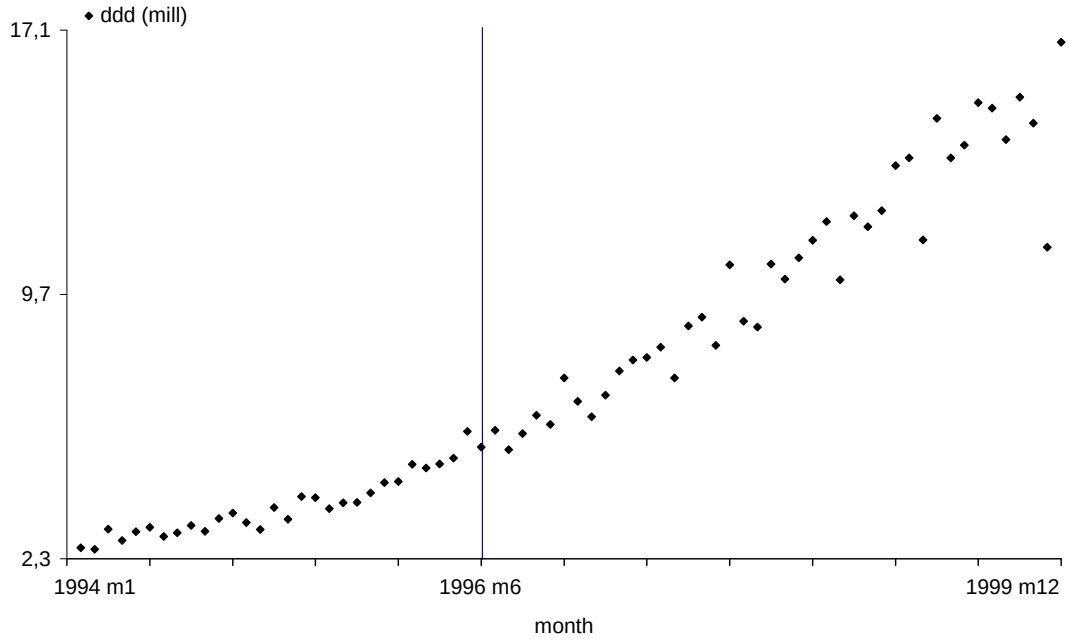

Figure 8 **Market size in million DDD's, Anti-depressants**

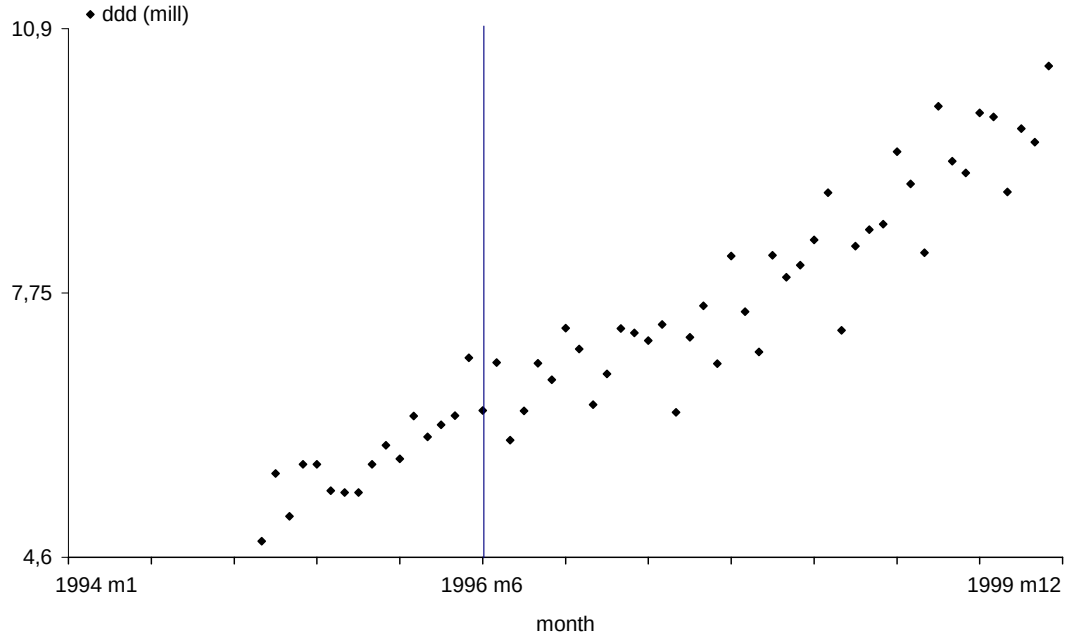

Figure 9 **Promotion to sales ratio, Anti-hypertension**

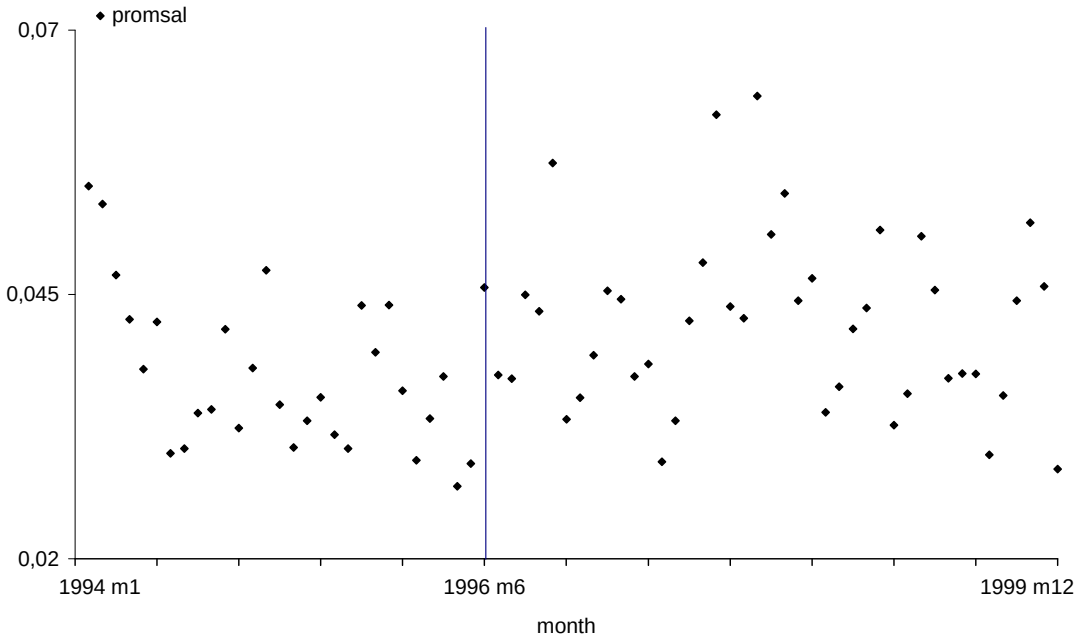

Figure 10 **Promotion to sales ratio, Anti-ulcer**

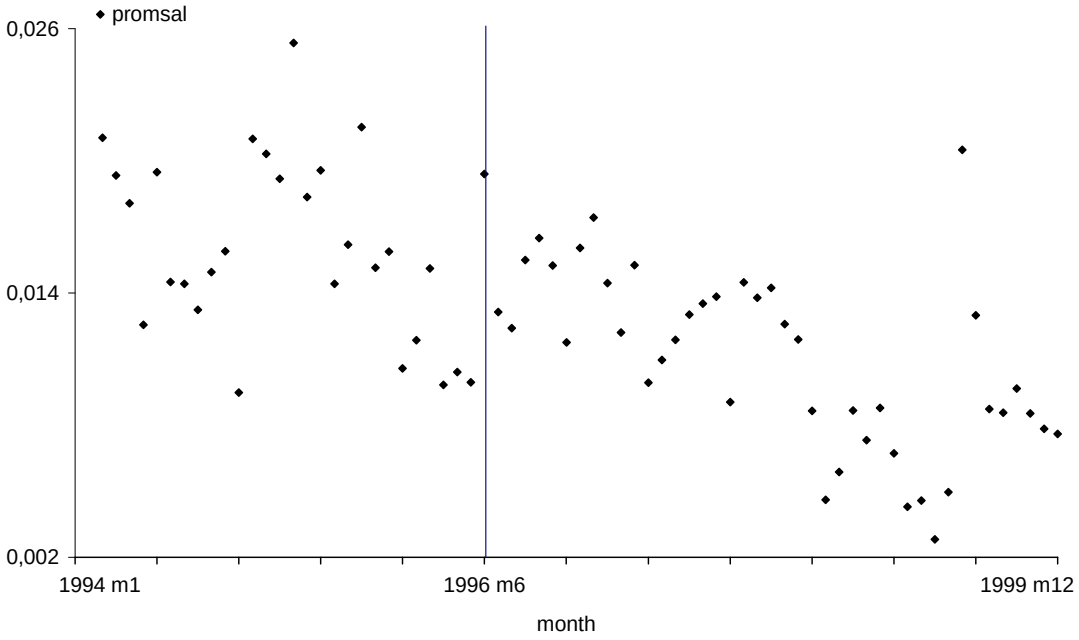

Figure 11 **Promotion to sales ratio, Cholesterol**

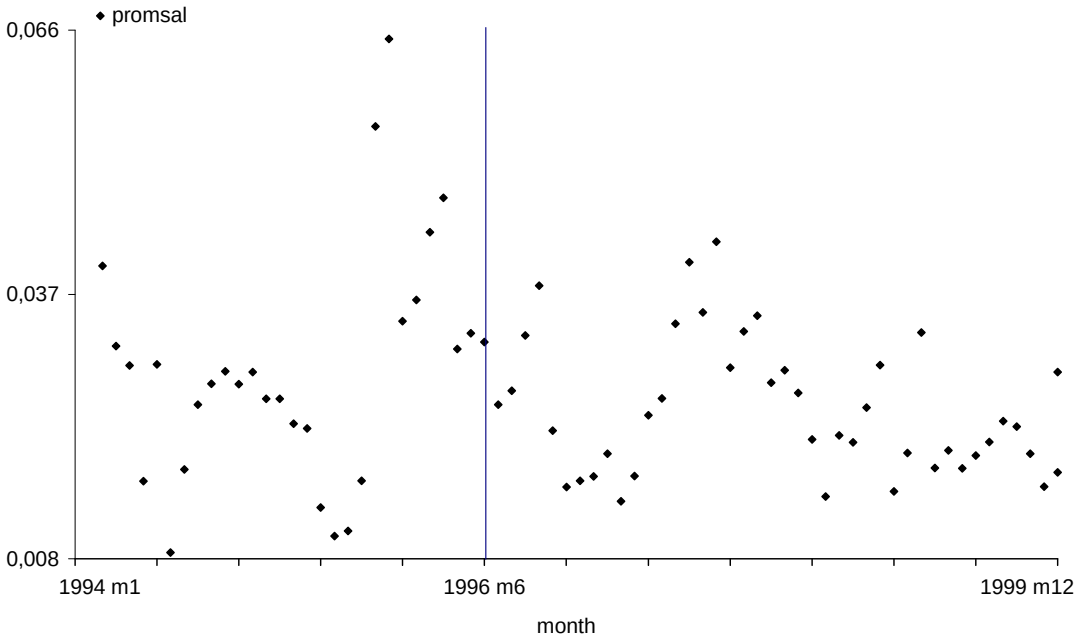

Figure 12 **Promotion to sales ratio, Anti-depressants**

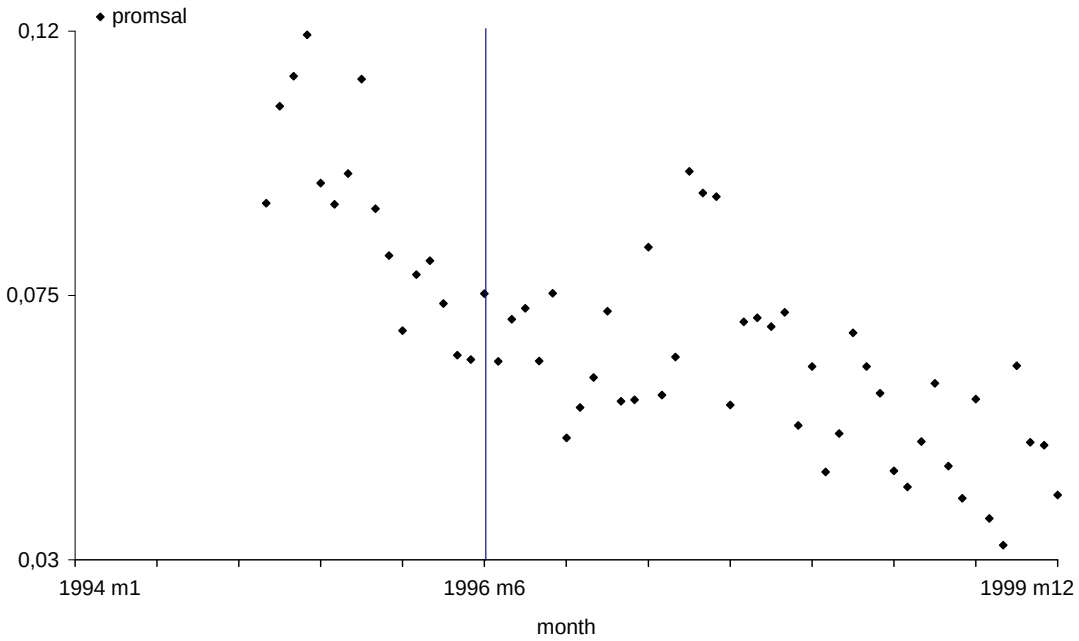

Figure 13 **Market shares Branded vs Generics, Anti-hypertension**

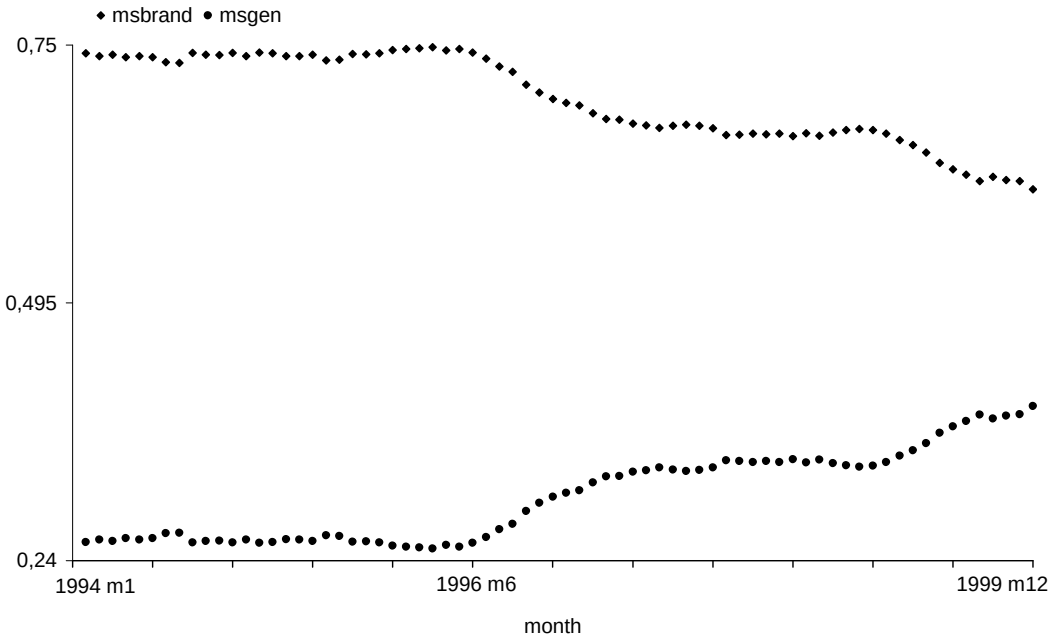

Figure 14 **Market shares Branded vs Generics, Anti-ulcer**

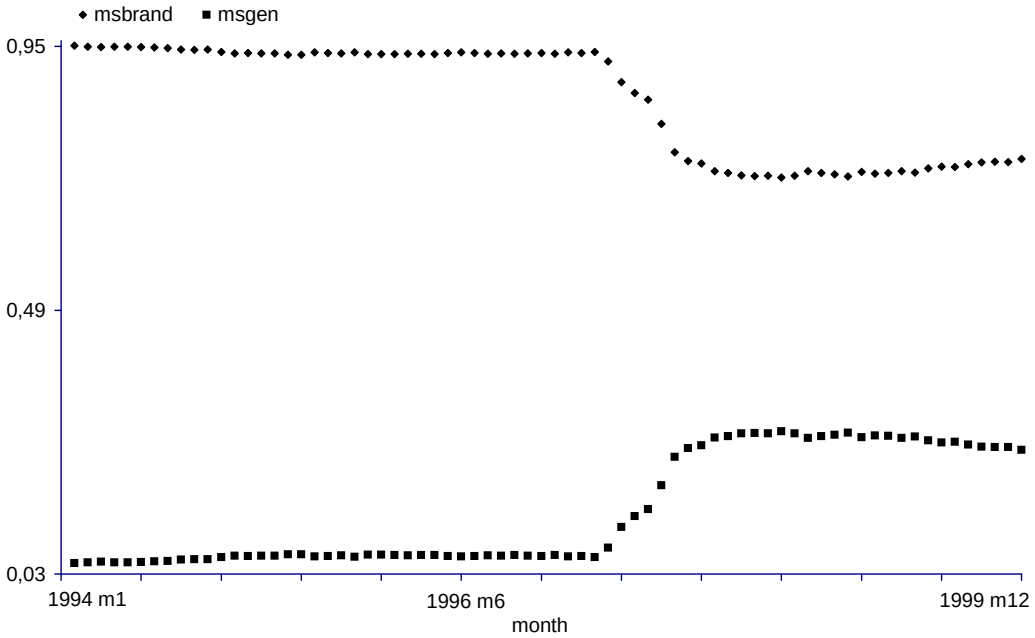

Figure 15 **Market shares Branded vs Generics, Cholesterol**

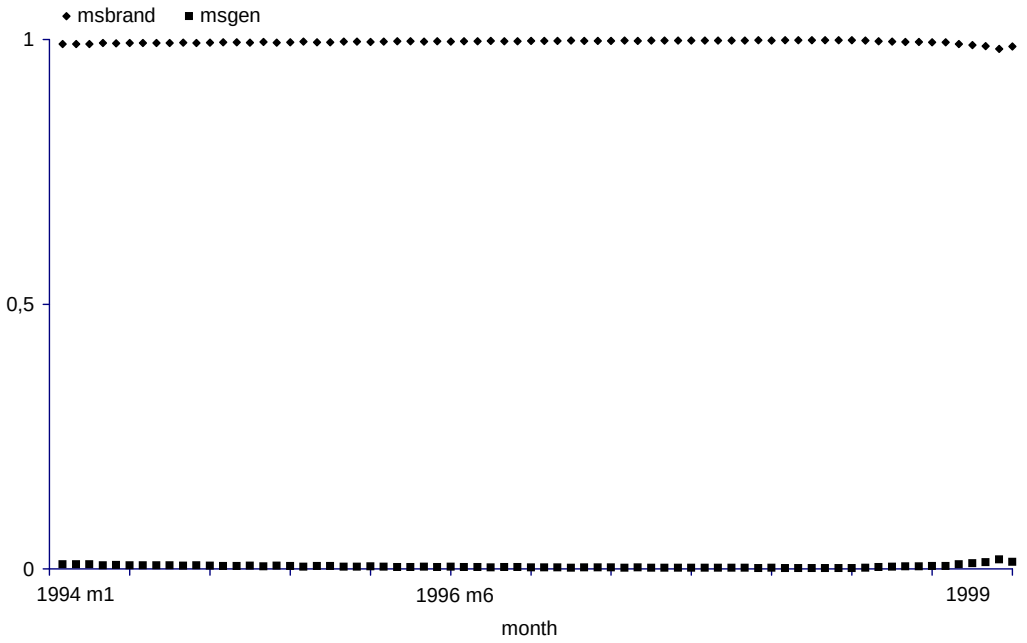

Figure 16 **Market shares Branded vs Generics, Anti-depressants**

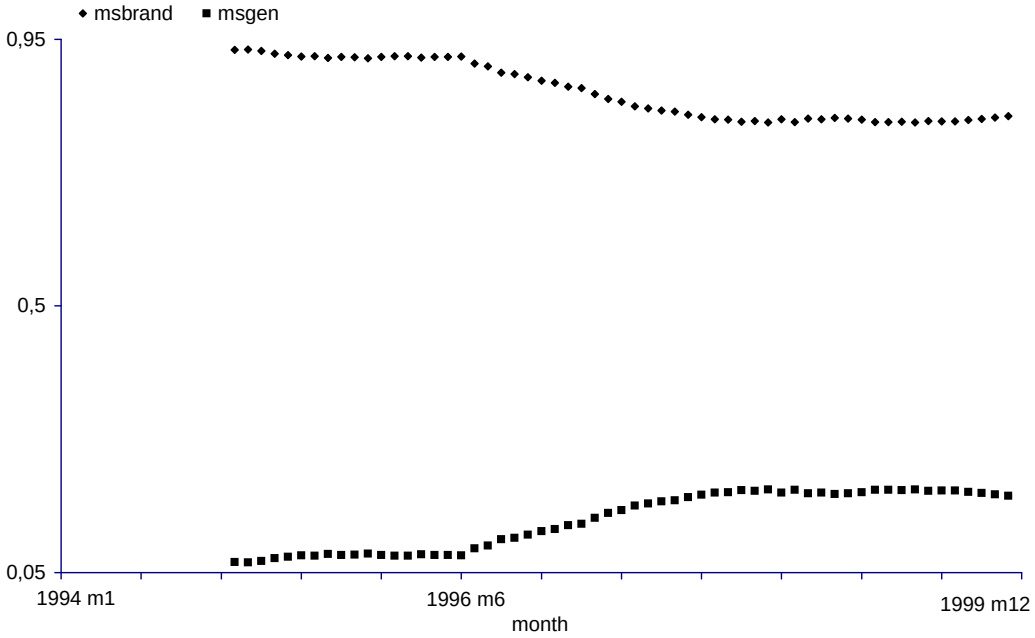

Figure 17 **Zantac and Generic Rantidine, in million DDD's**

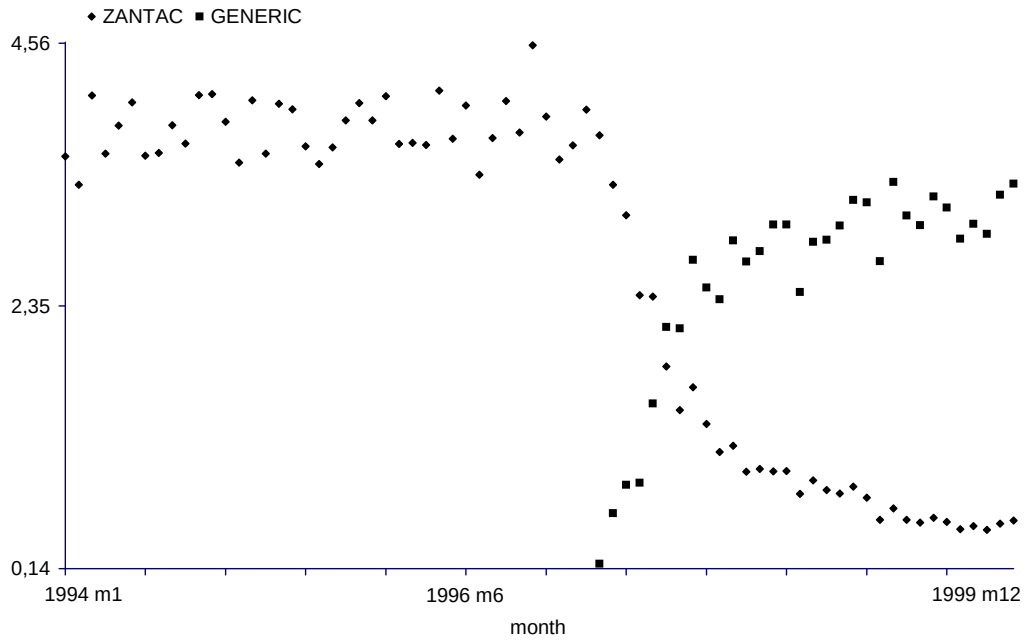

Figure 18 **Zantac and Generic Rantidine, Price (in Dfl=0,45 euro) per DDD**

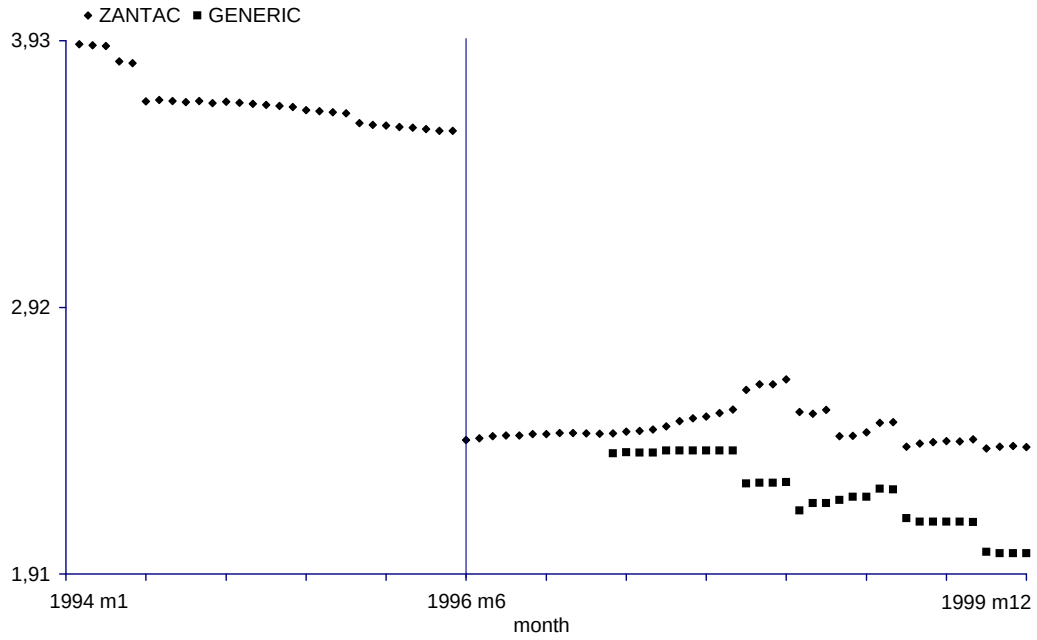

Figure 19 **Adalat and Generic Nifedipine, in million DDD's**

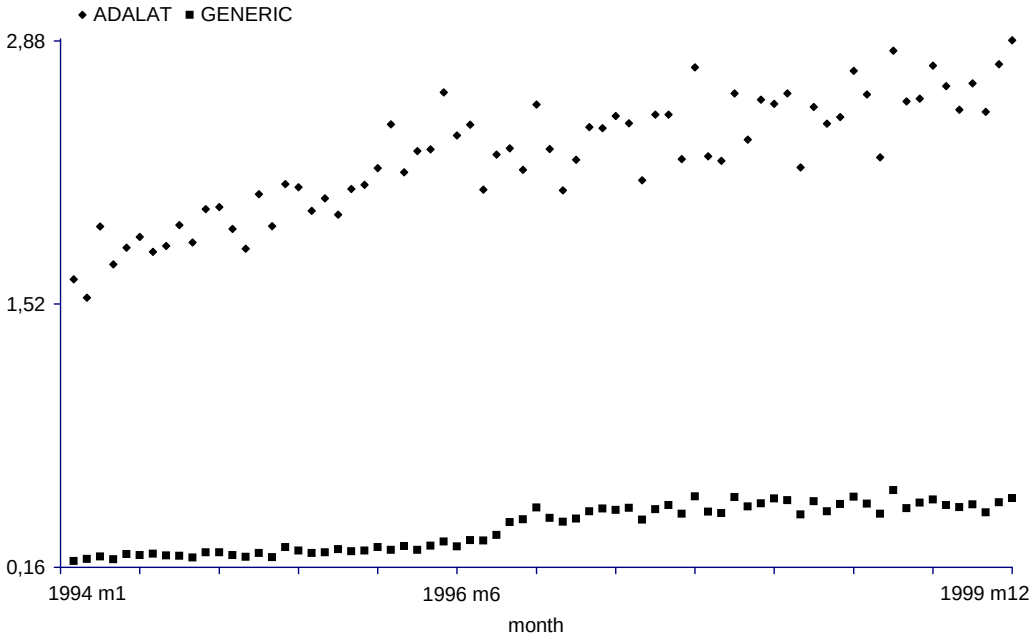

Figure 20 **Adalat and Generic Nifedipine, Price (in Dfl=0,45 euro) per DDD**

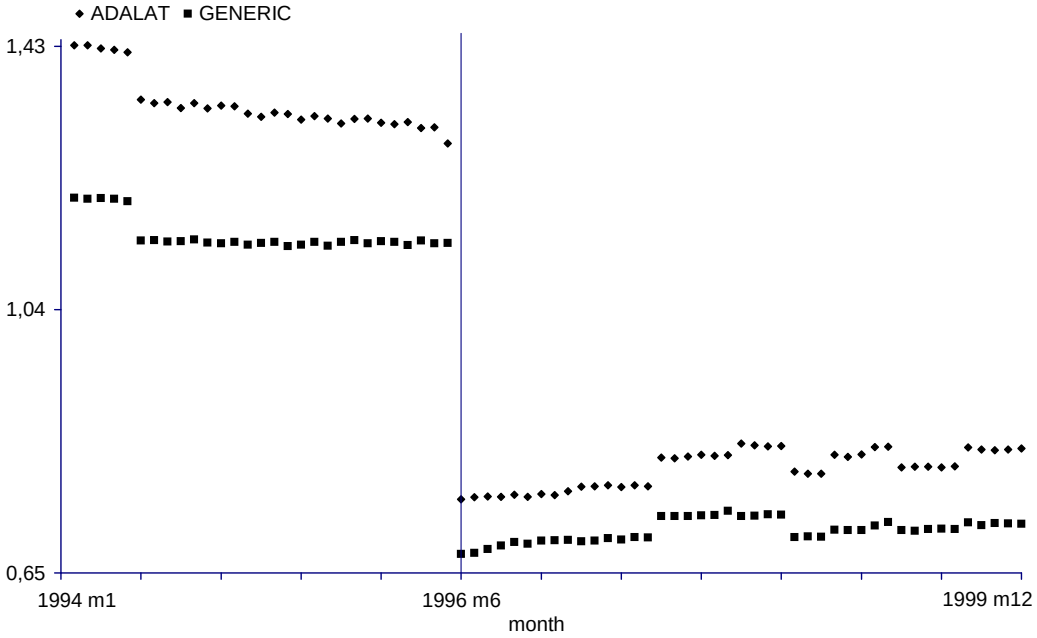

Figure 21 Log mean promotion expenditure (in Dfl=0,45 euro) by age (in month)