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The Norwegian market for pharmaceuticals and the non-mandatory substitution reform of 2001: the case of enalapril .*

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June 2004

ABSTRACT

A new demand model which accounts for the effect of the age of drugs on pharmaceutical demand is provided. Within this framework the problem of persistence in consumption of original branded drugs and a particular case of intra-molecular substitution are analyzed. I find that interacting price with time in a logit demand structure provides intuitive patterns of substitution between branded and generic drugs and yields, with an assumption of Bertrand-Nash-equilibrium on the supply side, intuitive dynamics of the mark-ups for generic manufacturers over time. The effect of a non-mandatory substitution reform introduced in Norway in March 2001 is analyzed in terms of increased sensitivity to price and is found to be negligible. The presence of competition between generic producers is also verified.

1. Introduction

Generic substitution represents an issue of great interest for all National Health Systems. Pharmaceutical markets are in fact characterized by the presence of new and cheaper versions of off-patent branded drugs. Since reimbursement of prescription drugs is one of the greatest items of public expenditures for health system such generic goods offer an equivalent therapeutic alternative to branded drugs and thus represent a great opportunity to save money.

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Innovation in the medicine field leads continuously to the production of new specific drugs that have more efficacy, require less dosing frequency but are also much more expensive than the existing mature medicines. Thus, the pharmaceutical market shows a continuous increase in prices. Aging population and improvement in diagnosis activities contribute to the rise in the level of consumption of these new patented drugs and the respective reimbursements paid by the state.

The analysis of pharmaceutical markets and especially of intra-molecular substitution, i.e. substitution of branded drugs with generic versions, has always highlighted an intrinsic advantage of the incumbent producer. Even after the period of patent protection branded drugs still have higher prices with respect to generic versions. This persistence in buying branded when perfect substitute and more cheaper generics are available is often explained in terms of habit formation in physicians prescriptions or patients consumption [see for instance Hellerstein(1998), Stern and Trajtenberg(1998)]. During the last decades national government focused their attention on this item of public expenditure and implemented policies aimed at encouraging generic substitution.

In spite of the fact that Norway is characterized by the second lowest per capita consumption of drugs in OECS-Europe [LMI 2000], the Norwegian authorities dealt with this problem and tried to encourage generics substitution with the introduction of various reforms.

The aim of this paper is to study intra-molecular competition. The paper provides a new structure to model demand for branded drugs and generics versions and it examines, within this framework, the effect of a reform introduced in Norway in March 2001 in order to encourage generic substitution in the market for prescription drugs.

The efficacy of the reform is analyzed in term of sensitivity to price before and after the reform. This reform consisted of two interventions into different aspects of pharmaceutical sector: the introduction of non-mandatory generic substitution at the pharmacy level and a deregulation of restrictions on pharmacy ownership.

Drug demand is modelled in such a way to account for the problem of persistence in consumption of off-patent drugs. Price coefficient estimates and elasticities estimates are expressed as a function of the time spent in the market by

the drug. As a result we get intuitive dynamics of the manufacturers mark-ups over time. The innovation in the estimates of demand parameters is the interaction between price and "age" of the product in the market, i.e. the time since the drugs enter the market. In addition to the price (difference) the product between price and "age" of the drug is introduced. In this way the coefficient of price is in some sense allowed to vary according to the time spent by the drug in the market. The brand loyalty is thus explicated in term of time which becomes a dimension of differentiation in the characteristics space. Previous works[1] on aggregate data and on generic prices were using time spent by the drug in the market as a determinant of mark-up in the price equation without distinguishing between effect related to demand or supply side. Differently from these studies I introduce the variable time in a more elaborated structure for demand.

The problem of endogeneity is solved with the use of instrumental variable techniques.

I focus the analysis of the effect of the reform on the demand of a particular chemical substance, enalapril. For this substance we can observe market share and prices before expiry date of branded, after the arrival of generics and after the introduction of the reform. It is thus possible to observe competition between branded and generics before and after the reform. Moreover, the drugs which contain 2.5 mg of this substance, have characteristics that allow us to neglect some problem of heterogeneity that usually makes problematic the analysis of consumption and prescription activities for most of the medicines in the market.
Focusing on aggregate market shares and prices of different versions of enalapril I assume that the choice made by the couple physician-patient follows a logit discrete choice structure. In this way I use the market shares and regress the difference of their logarithm to recover demand parameter estimates following the procedure of Berry (1994,2001).

The effect of the reform on demand is analyzed in terms of increased price sensitivity after the reform. The estimated increase in the price coefficient is small and insignificant. The reason of the failure may thus be identified in the weak powers given to pharmacist to apply substitution ,ie. in the non mandatory nature of substitution .

[1] See for instance Caves, Whinston and Hurwitz (1991).

With the estimated price elasticities and an assumption of Nash-Bertrand equilibrium on producers competition I compute Lerner indexes as a measure of the level of manufacturers market-power. Differently from previous studies[2] I examine Lerner indexes of generic instead of prices in order to verify the existence of competition between generics.

The paper, differently from some studies on doctors' prescribing behaviour (Johanesson M. Lundin D. (2002), Coscelli(2000), Crawford G., Shum M.(2003)) which exploit availability of individual prescription data over time, provides a procedure to account for persistence in consumption of more expensive drugs analysing aggregate market shares and shows that even by using this kind of data it is possible to obtain significant results in terms of price elasticities estimates, competition measures and evaluation policy.

Next section describes the characteristics of the Norwegian pharmaceutical market, the peculiarity of enalapril molecule and purposes of the reform. Section 3 contains a description of the model and of the estimation techniques implemented. Section 4 contains a description of the dataset used. Section 5 shows the estimation results and section 6 concludes.

2 THE NORWEGIAN PHARMACEUTICAL MARKET

Norway is characterized by a low consumption of drugs: per capita consumption of drug is the second lowest in Western Europe (LMI 2000). The pharmaceutical market is however one of the most regulated in Norway. Regulation in fact affects almost all the aspects of this sector. In particular it consists of a direct control of retail margins for prescription drugs[3] and of a deep selection of the drugs allowed to enter in the Norwegian drug market.

The main authority which supervisions all the activities related to pharmaceutical sector is the Norwegian Ministry of Health and Social Affairs. It is this Ministry that sets the retail margins. Through the control of a subordinated agency (the Norwegian Medicines Control Authority), the entrance of new type of

[2] Caves , Whinston and Hurwitz (1991) and Frank R.G., Salkever D.S. (1995) use number of entrants as an explanatory variable for generic prices.

[3] The market and prices for the over the counter drugs and pricing strategies are unrestricted. Reimbursed drugs (prescription drugs) are written on a blue sheet.

drugs in the Norwegian market is regulated. Its selection criteria are quite strict; the number of drugs registered during the last decade is much lower than the average of the other European countries[4]. The Norwegian Medicines Control Authority controls retail margins since it decides both the prices that the pharmacies pay to the distributors[5] (AIP i.e. wholesalers selling price) and the prices paid by the patients for the drugs in the pharmacies (AUP i.e. retailers selling price). The pharmacy profit consists of a percentage margin[6] based on the wholesale price and a fixed sum per package[7]. The manufacturer selling price (GIP) is instead not restricted.

The quality assessment and surveillance of safety requirements for old and new medicines is the task of the Norwegian Board of Health. The Board follows the flows of drugs from the manufacturers to the patients and has responsibility for the distribution of licenses for production and trade.

The Norwegian Health System assures public health insurance to all people living on its territory. The NIS (National Insurance Scheme) reimburses the greatest part of the cost of the medicine. During the years under examination the percentage reimbursed by the NIS didn't change.

[4]One of the reason was that drugs were accepted in the list of reimbursable drugs with a big delay. ESA, the surveillance authority of EFTA (European Fair Trade Association), was asking the respect of EEA agreement, the liberalization of the pharmaceutical market and more transparency in the criteria of drugs admission in the reimbursable list.

[5] The price of each drug must be lower than a ceiling determined as the average of the three lowest prices in a group of Northern European countries.

[6] This margin has been repeatedly reduced since from 1995.

[7] This fixed sum represents the greatest part of their profit.

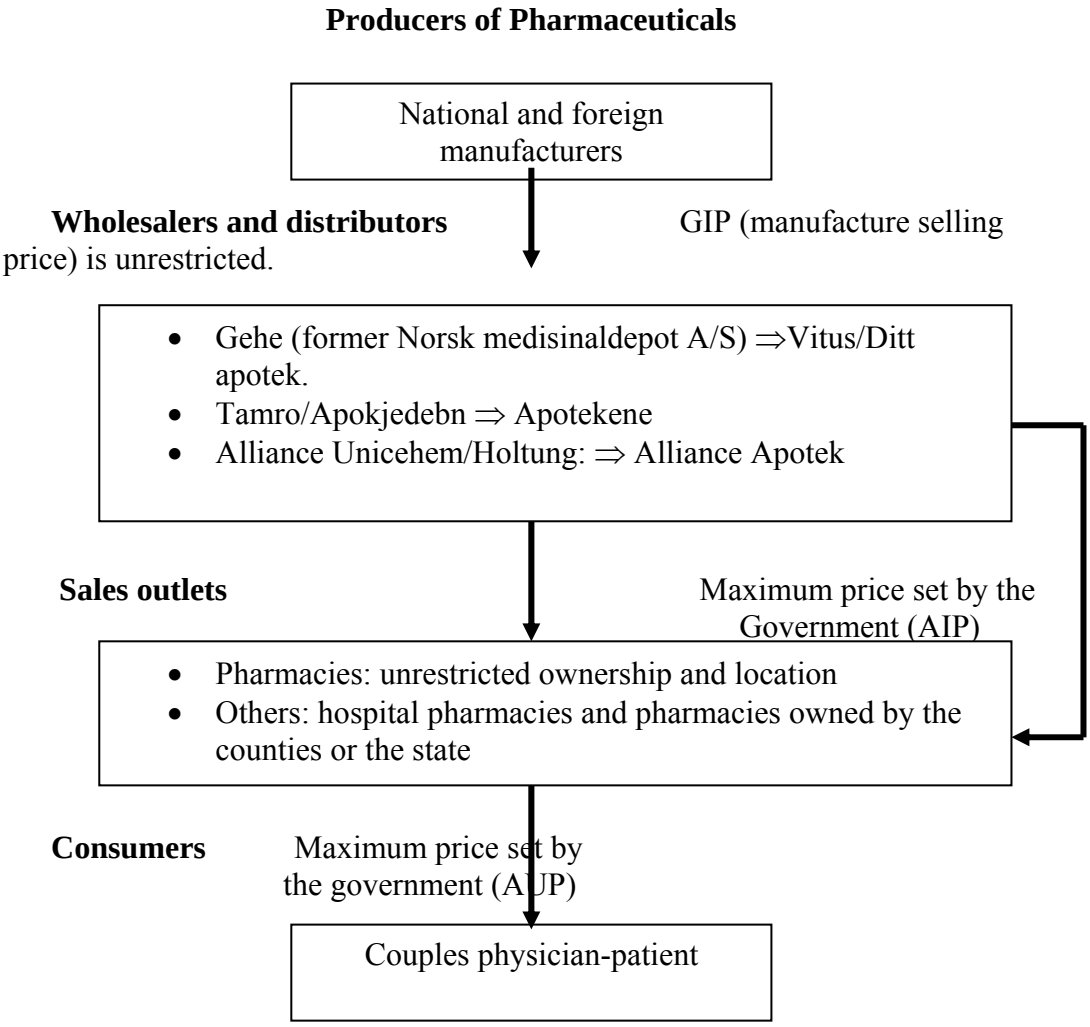

Figure 1: Flows of drugs from manufactures to consumers and government regulation.

During the last decade various reforms tried to encourage switching to generics. Parallel imports were introduced in 1998: pharmacists were allowed to import drugs at lower prices and to keep 50% of the savings. The margins for pharmacists were reduced several times in order to make substitution of branded with generics and the related savings more profitable and appealing.

Doctors were required in 1999 to prescribe the generic with the lowest price. However this recommendation and the reference price system[8] used were not sufficient to increase physicians' awareness on prices.

2.1 Generic substitution reform and deregulation of pharmacy ownership.

In 2001 generic substitution was introduced at the pharmacy level. With this reform pharmacists are compelled to inform the patients about the cheaper generic version of the same "molecule" and unless doctors forbid substitution in their prescription, they could deliver the one chosen by the patient. The substitution is not mandatory and thus also the patients may oppose to a change of prescribed drug.

Pharmacists are induced to substitute since they can keep 50% of the difference between the maximum AIP and the actual price. The list of the generic versions of a product is issued by the Norwegian Medicine agency).

The effect of this reform is the object of our analysis. In the same year of introduction of generic substitution there was also the liberalization in the regulation of pharmacy ownership. With the new pharmacy act on the 1st of March restrictions on ownership were abolished and pharmacists joined to the three main distributor chains[9]. The distribution sector is characterized by three new private wholesalers each of which is strictly connected with one pharmacy chain.

Until 1994 there was a monopoly of the state-owned wholesalers, the Norwegian Medicinal Depot. NMD was the unique company with the right to distribute and import medicine charging a fixed wholesale margin. In 1994 the monopoly ended and new wholesalers entered the market. NMD Norge, the former state wholesalers was acquired by Gehe. Gehe also bought some pharmacies and started a partnership with others; in 2001 Gehe (celesio AG

[8] The reference price system was introduced in 1993. With this system the price of the cheapest brand available on the market within each group of identical drugs was the basis for reimbursement. Each time the physician was prescribing a more expensive drug the patient had to pay the difference between the price and the amount reimbursed by NIS. This system was abandoned on 2001.

[9]The three main chains are Norsk Medisinaldepot A/S, Holtung AS and Tamro AS. Independent pharmacies represent only 5 % of the total pharmacies.

group) was controlling approximately 150 pharmacies belonging to the Vitus/Ditt Apotek.

The greatest between the new private wholesalers is Apokjeden/Tamro. Apokjeden was born in January 12th 1995 as a buying alliance for the member pharmacies. It started a partial cross shareholding deal in February 2000 with Tamro which completed in February 2001. The respective chain is Apotek1. The third wholesaler is represented by Holtung. This company was acquired by Alliance Unichem. (in 2000 51% owned by producers and the rest by pharmacies). The respective retailer is Alliance Apotek. Figure 2 shows the distribution of pharmacies in 2001.

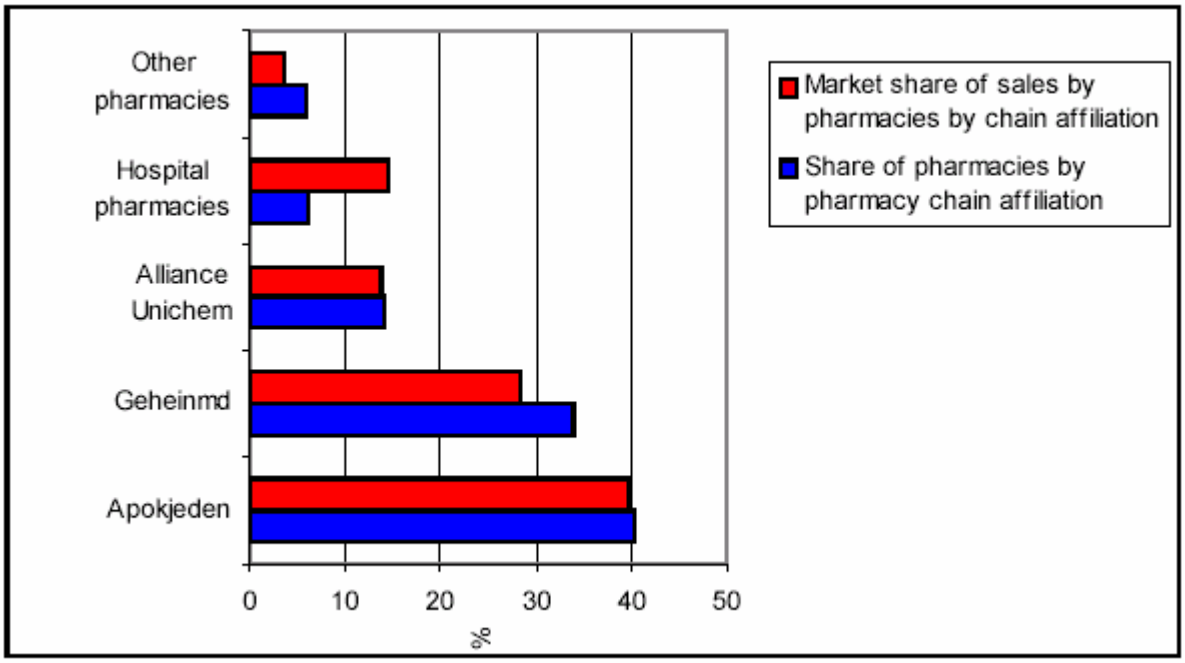

Figure 2: distribution of pharmacies in 2001. Source LMI 2001

These new distributors can negotiate their margin with the manufacturers. The wholesaler margin is one of the lowest in Europe(Source: The Social Insurance Institution, Finland, Social security and health reports 54, 2002.).

Before the new pharmacy act, location and number of pharmacies were decided by the Norwegian Health Ministry. The result of this strong limitation was a very low availability of pharmacies especially for a country like Norway which is the second most sparsely populated country in Europe. After the new act the role of the government is limited to issue licences to applicants that respects

the requirements[10] for owning and running a pharmacies. Provided that these requirements are satisfied, entry and allocation are free and decided by the market[11]; the government may still give incentives to pharmacies located in less populated area in order to assure them a reasonable profit.

Type of pharmacy	1995	1996	1997	1998	1999	2000	2001	2002
Pharmacies	250	247	249	249	254	256	260	353
Branches[12]	78	90	97	107	110	113	114	102
Hospital Pharmacies	27	27	28	28	28	28	28	28
Total	355	355	385	392	392	397	402	483

Table 1. Number of Pharmacies in Norway 1995-2002. Source Mossialos & Mrazek (2003).

2.2 Purposes of the reform

The aim of the substitution reform was to create a system of incentives for pharmacist able to induce them to substitute branded drugs with generic versions. By stimulating competition at the retail level the reform was expected to yields an additional and indirect decrease in the price of branded goods at the upper level of the distribution system.

Pharmacist's incentives alone were not considered sufficient; the same incentive was given in order to encourage parallel substitution and it didn't yield great results. Thus, together with generic substitution, the reform introduced also deregulation of ownership with the intention to increase competition at the retail level and lower prices. However the new pharmacy act allowed distributors to own pharmacies [13] and consequently it provoked the birth of vertical integrated firms through the emergence of big distribution chains. Even if the new vertical integrated structures could restrict the activity of its members, there was the idea that pharmacists would have found it profitable to substitute branded with generics. Pharmacists could exploit this possibility to substitute branded with

[10] For instance there are no restrictions on ownership but each owner must employ a licensed pharmacy director with an MScPharm degree. Doctors and manufacturers can not own pharmacies. A single chain can not control more than 40% of all pharmacies.

[11] In fact there are no restrictions on number of pharmacies in the same area or distances to be respected between old and new pharmacies.

[12] Pharmacist can not own more than on license but can open branches.

[13] With the maximum limit of 40% of all pharmacies.

generics and thus should have put pressure on the wholesalers linked to their own chain. In their turn these distributors may negotiate their margin with the manufacturers, and hence they should have been able to get branded goods at lower prices.

However the results of the reform were poor. The substitution of branded prescription drugs with their generic versions amounted only to 12% of total sales. This fact seems to suggest that the incentive to substitute at the retail level was not sufficient to affect the selling strategy of the integrated firm. One possible reason of the failure of the reform is that substitution of branded with generics may not be convenient for the fully integrated firm which may find more profitable to sell drugs at maximum AIP (AUP). The integrated firm of course adopts the selling strategy which maximizes its profit which depends on the cost paid to manufacturers (the margin bargained), demands and prices (AIP and AUP) at the lower levels.

Because pharmacists receive a remuneration linked to the profit of the chain/wholesalers, they may find it more profitable to follow the behaviour recommended by their chain. The association between pharmacist and wholesalers in fact leads to the implementation of common advertising or exposition strategy for all the firm belonging to the same chain but also a common selling strategy. Wholesalers can control all pharmacies selling activity by running a deep screening activity on the sales and on the percentage of generic sold thanks to periodical restocking of drugs.

Thus the reform instead of inducing a pressure from the bottom to the top was flawed by an uniformity in the behaviour of all the members of the same chains and by a recommended selling strategy imposed by the high levels (wholesalers). Selling strategies of pharmacists are thus restricted and the incentive to substitute may be neglected.

2.3 Enalapril

Enalapril is a molecule used against hypertension and heart failure[14]. It belongs to the family of medicine called Angiotensin Converting Enzyme (ACE). Hypertension consists of high blood pressure and the people affected by this

[14] See for renitec medical properties EMEA (2003).

condition have usually an age above 43 years. It can be diagnosed only through regular controls of pressure. Hypertension is called the silent killer because without clear symptoms it provokes serious damages to the health status. Enalapril molecule manages to lower blood pressure.

The use of enalapril is highly specific also for heart malfunctioning like asymptomatic left ventricular dysfunction or heart failure. Heart failure is a weakening of the heart. The heart doesn't manage to pump all the blood that body needs but it doesn't mean that the heart stops working and it is not necessarily the same as a heart attack. This state may start without any symptoms but then when the heart conditions are getting worse people start suffering the shortage of breath or feel tired after light physical activities. Enalapril may slow the progression of heart failure in patient with symptoms or in case of patient with heart failure, but without symptoms, or it may stop the heart muscle from getting weaker.

I focus my analysis on the prescription of enalapril for the heart failure. I consider only enalapril 2.5 mg[15]. This is the initial dose recommended only for the heart failure since it may induce hypotension or other considerable side-effects like increased kalium-level in the blood and kidney-failure (EMEA(2003))[16]. In this way I can analyse this market separately from other drugs which are therapeutical substitutes.Enalapril is considered the unique and best product for heart failure.

Figure 3 shows market share of branded and generics.

[15] The dataset described in section form contains information on all the different concentrations of renitec that is 2.5, 5, 10,20 mg.

[16] The initial dose for hypertension, even for very mild conditions of this disease, is at least 5 mg

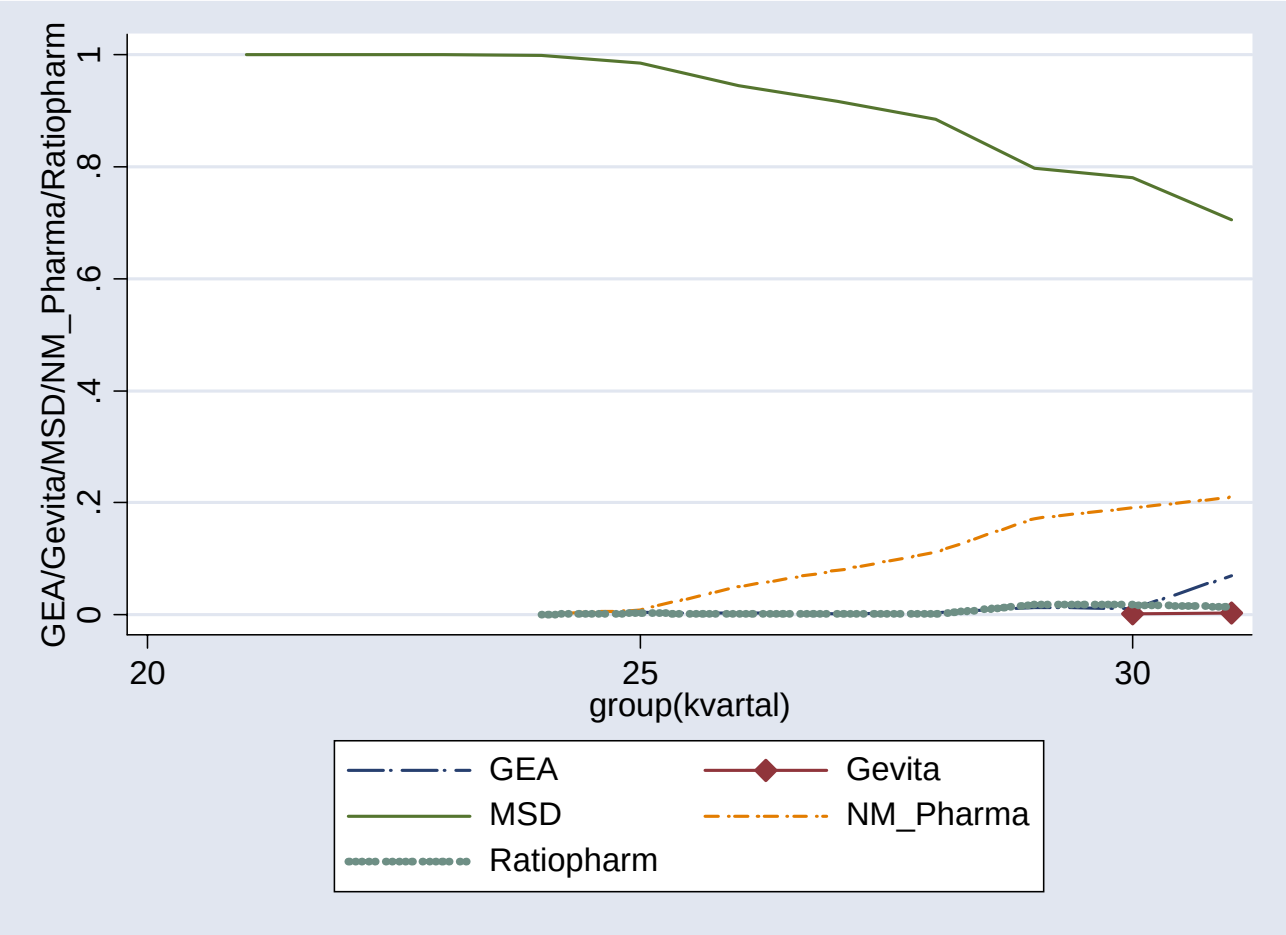

Figure 3. Market shares. Source: author's computation.

The enalapril molecule in Norway was first provided by MSD Norge[17] (named renitec) whose patent is protected till the third quarter of 1998. After the patent expired, i.e. last quarter of 2000, other firms have entered the market (GEA, NM Pharma, Ratiopharm, Gevita with the name renitec and enalapril). For all the period under study Renitec MSD has maintained the highest market share, which decreased slightly over time and reached a minimum of 70% in the 31st quarter. In contrast generic market shares have increased over time. The maximum market share for generics is represented by NmPharma, i.e. 20% on the last quarter.

[17] A branch of Merck who invented the molecule in 1984.

3 The model

3.1 Demand side

Most of the literature about pharmaceutical products stresses the importance of the nature of relationship physician-patient in the decision of the prescribing drug. The observed market shares are the results of the decisions of different couples of patients and physicians (we are excluding for the moment a role for the pharmacist which actually after the reform may substitute branded drugs with generics). Physicians' diagnosis procedure and prescribing behaviour may be influence by brand loyalty (Hellerstein (1998), Stern and Trajtenberg(1998)). Many authors underline the effect of patient learning experience Crawford and Shum (2003), Park (2000)], the existence of costs for patient of switching from the previously consumed drug to another [Hellerstein(1998)], or non compliance problem [Ellickons P. et al (1999)]. Most of these studies use individual data on prescriptions to solve the problem of unobserved heterogeneity.

In this study there are two possible double sources of heterogeneity which are not accounted for because of the aggregate nature of the data. However for the drug under examination heterogeneity in diagnosis and prescribing procedure may be considered minimal since the pathology is easily identifiable by all kinds of doctors and the enalapril is a highly specific therapy for almost all the states of heart failure or asymptomatic left ventricular dysfunction. The short length of drug-taking for enalapril 2.5 is not sufficient for learning experience, and the life threatening feature of the diseases suggests that problem of non compliance or heterogeneity in prescription due to patients attributes may be neglected. The decision process may be described as follows.

The doctor makes a diagnosis for the patient and matches this pathology with the best drug available to cure it. One problem of this decision procedure is that often the physician is not considered as a perfect agent as regard to the costs for consumers of the drug. . Because the Norwegian government covers a substantial part of the expenses on prescribed drugs, the couple doctor/patient has weak incentives to minimize costs. Since it is a third part to pay the cost this is a classical moral hazard problem.

In the case the physician matches perfectly the drugs feature to the patients' pathology and also completely takes account of the price paid by the patient, the drug chosen for patient *i* will be that one which gives the highest utility[18]. In this case the couple physician-doctor can be considered as a unique agent[19] to whom I will refer as "consumer" *i.* Pharmacists are thus excluded from the demand side because of the non mandatory nature of the substitution reform and they are considered part of the supply side[20].

I define the utility of consumer *i* from consuming product *j* as :

$$U(\varsigma_i, p_j, x_j, \xi_j; \theta)$$

where ς is a vector of "consumer" characteristics, p_j are the prices, x_j are the observable product attributes, ξ are the unobservable ones and θ are demand parameters. "Consumers" are thus differentiated by different ς, whose distribution is known to the econometrician: this fact allows them to make different choices. "Consumer" chooses product *j* instead of any other product if:

$$U(\varsigma_i, p_j, x_j, \xi_j; \theta) \geq U(\varsigma_i, p_r, x_r, \xi_r; \theta) \text{ For any } r = 1,2,....,f \text{ .}$$

It is the joint distribution of consumer characteristics, and product attributes, that determines the preference over the products marketed and consequently the market share of each of these products.

Many studies show that demand for drugs (generic versus branded) may depend on consumers' characteristics [21] but in the case under study the only heterogeneity in consumers' taste is represented by the i.i.d. error term since other characteristics of patient and doctors are not available.

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[18] For a deeper formalization of agency problem in prescription see Rika Onischi Mortimer (1997).

[19] This approach consider the role of physician as predominant; the patient once he choose the physician has no more power and follows exactly its instructions.

[20] Ellison, Griliches & Hausman (1997)consider the consumption decision as consisting of two steps: the consumption choice of the physician-patient couples and the consequent decision whether to substitute or not made by the pharmacist. Their use of a multistage budgeting structure to model demand is justified by the mandatory nature of the reform.

[21]Stern & Trajtenberg [1998] and Hellerstein[1998] for the role of physicians and patients characteristics.

If we define A_j as the space of values of ς, which make the consumer choose good *j,* we can specify the market share for this product as:

$$s_j(p,x,\xi;\theta) = \int_{\varsigma \in A_j} P_0(d\varsigma) \qquad [1]$$

where $P_0(d\varsigma)$ is the density distribution of ς.

The vector of demands for good *j* in all markets is equal to the product of each share for the respective market size. These market shares are specified as the total number of doses per day[22] sold by each firm divided by the total number of doses sold by all producers in the quarter. Due to the particular nature of the product under examination it is possible to neglect the problem of multiple purchases.

In the very simple specification with an additive error term, independently distributed across consumers and products characteristics, the utility function is:

$$U(\varsigma_i, p_j, x_j, \xi_j; \theta) = x_j\beta - \alpha p_j + \xi_j + \varepsilon_{ij} = \delta_j + \varepsilon_{ij} \qquad [2]$$

where $\delta_j = x_j\beta - \alpha\ p_j + \xi_j$

As already mentioned the vector of ε represents the only unobservables of consumers' characteristics, ς, and therefore they are the unique variation in consumers' tastes present in this model. δ_j represents the mean utility level and ε_{ij} the deviation from this mean due to taste heterogeneity.

In the literature physicians are often considered perfect agents for what concerns the matching procedure of pathology and medicine. However they do not often internalise the aspects related to the price. A common suspect is that doctors do not know prices of the prescribed drug (they also do not know all generics) and that also advertising directed to them is lacking this kind of information. Therefore the price coefficient in this paper has to be considered as sensitivity to price of the couple doctor physicians[23]. The effect of reform is measured as the induced change in this price sensitivity.

[22] A useful method of comparison between packages with different number of pills is to use the number of DDD, i.e. defined daily doses.

[23] In general the interpretation of this coefficient might be more complicate. The cost of the drug sustained by patients may vary and be covered by different type of insurance (public or private). If physicians internalised this aspects the joint utility function becomes more complicated. In the present case I neglect this aspect since in Norway the percentage non reimbursed by the state is the same for everyone, that is 36%.

In this study the only attributes of the product which may be interesting are the price and the time spent by each drug in the market. All the other attributes which may refer to characteristics of the packaging (colour, size etc) or non observable factors (reputation, prestige), which do not vary over time, can be captured by a specific dummy for each product or simply using a fixed effect estimation procedure.

By assuming that the error term ε_{ij} is distributed as independent type I extreme value the integral for market share in equation [1] has the advantage to lead to the well known closed form, the logit.

In logit models, thanks to the assumption of i.i.d. error, the predicted market shares is the average probability for product *i* to be chosen. By using the branded drug as base category[24] the estimated market share is:

$$\phi_{i1t} = \frac{\exp(\alpha_{it} P_{it} - \alpha_{1t} P_{1t})}{1 + \sum_{k=2}^{4} \exp(\alpha_{kt} P_{kt} - \alpha_{1t} P_{1t})}, \text{ for } i=2\text{-}5 \text{ (generic versions)} \qquad [3]$$

$$\phi_{1t} = \frac{1}{1 + \sum_{k=2}^{4} \exp(\alpha_{kt} P_{kt} - \alpha_{1t} P_{1t})}, \; i=1 \text{ where } i=1 \text{ is the incumbent.} \qquad [4]$$

Let

$$\alpha_{it} = \gamma_0 + \gamma_1 \frac{A_{it}}{A_{1t}} \qquad i=2\text{-}5 \qquad [5]$$

$$\alpha_{it} = \gamma_0 + 1 \qquad i=1 \qquad [6]$$

ϕ_{it} is the market shares of product *i* at time t. P_{it} is the price of product *i* at time t. A_{it} is the time occurred since the entrance of generic producer *i*. $A_{1\text{t}}$ represents the time spent by the original branded drug in the market. γ_i is a time invariant individual (firm) specific effect.

The coefficient of price differs between generic and branded drug as shown in equations [5] and [6].

The computation of coefficients thus comes out from a comparison between generics and the branded drug. As already mentioned I assume irrelevant the problem of non-compliance highlighted in other works since Enalapril 2.5 is

[24] Thus I assume there is no outside good whose utility an be normalized to zero.

prescribed for a short period and the cost sustained by the patient is a small percentage of the overall price of the medicine[25].

The particular structure of the price coefficient is necessary in order to make the model more realistic and to solve some drawbacks of the logit specification; the use of price as unique time varying regressor may in fact be misleading: since branded drug with highest price have the greatest market shares there would be a positive correlation between quantity sold and prices which of course would bias estimated coefficients.

The particular formalization of price coefficient is introduced to solve the well known drawbacks of a simple logit and to deal especially with unreasonable substitution patterns and counter-intuitive mark-up estimates. The problem of simple logit specification is due to the additive and separable error term. Because the distribution of ε_{ij} is independent of the observed attributes market shares, all substitution effects and price elasticities are totally determined by mean utility level δ_j [26]. This fact implies that products with the same market shares have the same cross price elasticities with respect to any third product (IIA)[27]. A common critique to this property is that an increase in the price of a third good would influence in the same way two goods with the same market share, irrespective of how much similar the characteristics of these two good are to the attributes of this other good whose price has changed. In the case under examination if price were considered as unique time varying dimension of differentiation the other similarities among generics would be neglected.

Moreover in a simple logit with price as an unique regressor, also the other properties of market demand would be affected by the assumption of i.i.d distributed additive error; products with the same market shares have in fact the same own-price demand derivatives. Another drawback, as underlined by Nevo(2000), is that the own price elasticities are almost proportional to the

[25] The percentage of the cost paid by the patient is 36%.

[26] This assumption of independence implies that product characteristics are exogenous. It may be reasonable if we consider these characteristics to be determined by firms in the short run. Especially for this kind of goods, whose production must respect specific rules and must use recognized know how, this assumption can be considered quite plausible.

[27] In fact drugs with similar market shares, and similar values of time of entrance and of prices have very similar dynamics of Lerner indexes, the Lerner index I defined as the ratio of price minus unit costs to price.

price[28]. A direct consequence of this would be a higher mark-up for drugs with low prices (generics); this fact of course is counter intuitive.

The additional term $\gamma_1(A_{it} / A_{1t})$ in the price coefficient is introduced just in order to relax the implications of these properties and to account for the brand loyalty or the habit aspect in prescription and consumption of drugs. The product between the price and the time spent on the market by each firm, $p_{it}(A_{it} / A_{1t})$ becomes another attributes of differentiation. With the formalization of equation [5] the coefficient of price is in some sense allowed to vary according to the time spent by the drug in the market relatively to the time spent by the original product. The brand loyalty is thus explicated in term of time which becomes a dimension of differentiation in the characteristics space[29]. Generics drugs showing similar value of time of entrance are thus distinguished from the branded drug.

The interaction term $p_{it}(A_{it} / A_{1t})$ should capture the information aspect in doctors' prescription behaviour and absorb part of the increasing level of celebrity of the generics with respect to the branded good.

The own price elasticities[30] contains in fact a α_{it} composed by a coefficient γ_0 expected to be negative and a coefficient γ_1 multiplied by time expected to be positive. That is the price coefficient and therefore the own price elasticities becomes smaller in absolute terms over time. This is consistent with the idea of generic products gaining more trust over time from the market, becoming less price-elastic and increasing their market power. At the same time the increased market share of generics makes the term (1-ϕ_{it}) lower and this contributes to the decrease in the price elasticity.

The time spent in the market by the generic manufacturer is divided by the time spent by the time spent by the branded good (thus this variable is equal to one for the branded good) in order to assure that the term A_{it} / A_{1t} doesn't increase without limit. This term converges to one as the time spent by the generic product increases. Thus, intuitively price elasticity for generics thus decreases

[28] This occurs especially when the factor $\alpha_{it}(1-\phi_{it})$ is constant.

[29] The variable time introduced alone in the demand equation since it doesn't vary (it increase constantly over time) across different drugs would becomes part of the fixed effect.

[30] In logit the derivative of market shares with respect to price is: $(\partial\phi_{it} / \partial p_{it}) = \alpha_{it}\phi_{it}(1-\phi_{it})$,and the price elasticity is $\alpha_{it} p_{it}(1-\phi_{it})$.

over time but at decreasing rates and converges to the minimum level $\alpha_{it} = \gamma_0 + 1$.

Even with the inclusion of time variable the properties of logit model could be considered too strong. Generic drugs with similar market shares and time of entrance have same elasticity, patterns of substitution and mark-ups. However I claim that in the case under study the two dimensions used, i.e. time and price, are sufficient for a good representation of the problem. The substitution patterns implied by these assumptions may be considered reasonable since generics have exactly curative property of branded drugs[31] and it is very unlikely that patients have different tastes for the same molecule under different form of the packaging or that they start to experiment to find the best drug for them[32]. Many studies which utilize survey or prescription data find that older people and consumer of drugs for life-threatening diseases, or chronic condition, [Scott Morton (2000)] are less likely to change product and in general that they receive the branded goods.

By using a well known technique in both the specifications(see for instance Berry 1994) one can get a linear function of the regressors of interest by inverting the market shares. By substituting [5] and [6] inside equations [3]and [5] it is in fact possible to compute the mean utility level as difference in the logarithms of two market shares.

$$\ln\left(\frac{\phi_{jt}}{\phi_{1t}}\right) = \gamma_0(p_{jt} - p_{1t}) + \gamma_1(p_{it}\frac{A_{it}}{A_{1t}} - p_{1t}\frac{A_{1t}}{A_{1t}}) + \gamma_i + \mu_{it} = \\ = \ln\left(\frac{\phi_{jt}}{\phi_{1t}}\right) = \gamma_0(p_{jt} - p_{1t}) + \gamma_1(p_{it}\frac{A_{it}}{A_{1t}} - p_{1t}) + \gamma_i + \mu_{it} \qquad [7]$$

where γ_i represents all attributes and unobserved aspect that are fixed over time. μ_{it} is the difference between two i.i.d. error terms and the interpretation of these error terms is given in the next session..

We can regress this equation by fixed effects to compute the estimates of γ_0 and γ_1 and use these to calculate $\hat{\alpha}_{it}$.

[31] In order to be admitted to the market the just have to prove this similarity (molecule , shelf life, etc.).

[32] The length of consumption of enalapril, according to advised therapy, should be very short. This can reduce another form of non compliance due to the learning experience of patients which may try different product and switch from the prescription of the physician.

3.1.2 Endogeneity problem

Empirical results suggest that there might still be endogeneity or time varying omitted attributes not accounted for by the use of fixed effect and price-time variable. The presence of endogeneity may be due to the presence of omitted attributes that vary over time and are related to the unobserved quality factors of the drugs such as increasing level of confidence in the product. Prices may still be correlated with the error term in the market share equation. Thus fixed effects estimations leads to inconsistent estimates and to an underestimation of α_{it} (too small negative values of γ_o) and thus to an overestimation of all Lerner indexes.

Let's assume that the underlying utility has the form:

$$U_{it}(\varsigma_i, p_j, x_j, \xi_j; \theta) = x_j\beta - \alpha_{it}p_j + \xi_j + \psi_{jt} + \varepsilon_{ij} = \delta_{jt} + \psi_{jt} + \varepsilon_{ij} \qquad [8]$$

where $\delta_{jt} = x_j\beta - \alpha_{it}p_j + \xi_j$ is the mean utility level and ε_{ij} the deviation from this mean due to taste heterogeneity. ξ_j is a unobserved drug quality which is assumed to be constant over time. ψ_{it} is instead the unobserved quality that changes over time. Time terms represent all the omitted attributes that change over time and affect demand and are thus related to the aspect of brand loyalty and habit formation. They are observed by consumers (physicians) and producers. Thus producers may set higher prices because they know their drug has a higher unobserved (to us) quality. By exploiting the distributional assumption on ε_{ij} and getting the logit closed form the difference between the two unobserved qualities becomes our error term. In the first specification (the second specification has the same notation apart the different time variable) equation [9] becomes:

$$\begin{aligned} &\ln\phi_{jt} - \ln\phi_{1t} = x_j\beta + \gamma_o p_j + \gamma_1 p_j A_j + \xi_j - x_1\beta - \gamma_0 p_1 - \gamma_1 p_1 A_1 = \\ &= (x_j - x_1)\beta + \gamma_0(p_{jt} - p_{1t}) + \gamma_1(p_{jt}A_{jt} - p_{1t}A_{1t}) + (\xi_j - \xi_1) + (\psi_{jt} - \psi_{1t}) = \\ &= \gamma_i + \gamma_0(p_{jt} - p_{1t}) + \gamma_1(p_{it}A_{it} - p_{1t}A_{1t}) + \mu_{it} \end{aligned} \qquad [9]$$

The fixed effect coefficient γ_i captures what is constant over time that is attributes x_j and also the unobserved constant quality. Since there is a relation one to one between product and firm, the fixed effect is product and firm specific. The last term is the error term μ_{it} of equation (2) and it includes now unobserved

attributes that change over time and are correlated with the price. Because of this correlation the estimates of γ_0 are inconsistent.

In this model the loyalty for an "older drug" is accounted for by the interaction term $p_{it}A_{it}$. However there still might still be some unobservable quality (prestige,etc.) due to other factors. Therefore I tried to instrument the price by using two stages least squares estimation. The instruments should be variables that affect supply side, i.e. cost shifters. These are variables correlated with cost but uncorrelated with the unobserved quality.

In order to get instruments I exploit the information contained in the dataset, in particular I use the price of enalapril 5 mg. Other works (Hausman et al. (1994),, Nevo (2000)) use prices of same or similar product in the different market as instruments[33]. This instrumental variable is correlated with real costs since the molecule and all the other inactive substances contained in the drugs are the same. Thus, this instrument is strong. Of course one may argue that this price is also correlated with unobserved quality, as in the case of enalapril 2.5, and thus it is subject to the same problem of endogeneity. However the market for Enalapril 5 is different in many aspects. There are more generics in the market (seven) and there are two branded goods (MSD NORGE and PARANOVA) that compete in the market from the very beginning (1995). Paranova is a company specializing in the parallel imports. Thus, in the market of enalapril 5 mg there is a drug whose lower price is motivated by greater efficiency in production or other conditions present in the foreign market. Another difference is that entrance of generic producers occurs two quarters in advance with respect to the market for enalapril 2.5. Moreover enalapril 5 mg is used for the same pathologies of enalapril 2.5 mg and for the treatment of hypertensions. Since hypertensions is cured also by other numerous molecules different from enalapril, the number of competing products is much higher in the market for enalapril 5 mg and theory suggests that the presence of therapeutic substitutes increases level of competition.

Because of this higher level of competition, different dynamics of entrance and a greater maturity of these markets prices should be more close to the real marginal costs.Because firms should follow different strategies for setting mark-

[33] Hausman, Leonard and Zona (1994) use price of the same product in different areas as instrument. They assume these prices are correlated to the common marginal cost and that the disturbances due to promotional activity are independent across markets.

ups over time they should be less affected by omitted attributes. Thus the unobserved disturbances that contribute to determine prices in the two market can be considered independent.

I then use as an instrument, the quantity sold by each firm in the same therapeutical class (all the drugs whose atc code[34] starts with "C" letter, apart of course enalapril). Numerous studies in IO use characteristics of the same firm or of other producers as an instrument[35]. As in Brenkers & Verboven (2002) I use number of good sold by the same firms as instrument[36], since this variable is positively correlated with prices due to the following reasons. This variable contains useful information, especially in a highly regulated market of pharmaceutical products where entry of other firms is difficult. Studies on entry decisions[37] in different national pharmaceutical markets highlighted that the number of drugs already present in that country of the same firm affects positively the probability of entrance of other medicine of the same brand. This number is a signal of the profitability of the firm in the market and also of a greater familiarity with all the procedures required by the strict Norwegian bureaucracy system. I extend this concept by using all the number of packages sold by the same firms for all molecules provided. This variable in fact contains more information than the number of drugs present in the market since it is related with other aspects of the demand and supply side.

It is worth noticing that in principle this variable should be uncorrelated with the unobserved quality specific of enalapril molecule since it refers to what happens in other markets. However, there are two possible reasons that can flaw the validity of this instrument.

The first concerns the fact that the higher amount of sales in the same therapeutical class might be an effect of the higher or increasing unobserved reputation of the producer firm. If this unobserved prestige also affects demand of consumers and represents an omitted attribute of the market share equation, this variable cannot be considered as a valid instrument.

[34] ATC is the Anatomical Therapeutic Chemical. It is an international classification of drugs according to their therapeutic use.
[35] The equilibrium conditions show that prices depend on market shares which in turn are affected by characteristics of the other products.
[36] Brenkers & Verboven(2002) estimate a nested logit regression and use as an instrument the number of products of each firm in the same nest.
[37] See for instance Scott Morton (1997) and Margaret K. Kyle (2002).

The second possible drawback of this instrument is the fact that this variable may be a proxy for the successful contacts between the pharmaceutical firms and the physicians say, through the intermediation of other agents. Larger companies may invest more in advertising due to economies of scope in this activity, and thus may have more opportunities to remind doctors the name of the product or to affect their prescription behaviour.

However I claim that problem of the loyalty of physician and patient to a brand is mainly determined by a problem of information about availability of different version of the same drugs and that it is somehow distinct from the aspect of the reputation of the firm and persuasion induced by promotional activities. Many studies on generic entry[38] find that advertising expenditures of branded firm do not determine a barrier to entry and that they start to decline before patent expiration[39]. Generic drugs are characterized by very low promotional expenditures. Thus, loyalty to a product seems to be mainly an effect of stickiness in consumption. Patients may have difficulties to switch to other products, fact that may be internalised by the physician; doctors themselves might remember more easily the first drug introduced in the market and not the latter ones and they may invest few resources in gathering information about new versions. Hence, the effect of promotional efforts by new firms, especially for a drug like enalapril with particular directions for use, is less relevant for drug demand by the couple physician-doctor. Considering that reputation effect can be sufficiently controlled for by using fixed effects technique, it is quite safe to assume that the instruments are not correlated with the unobservable attributes and that the validity condition is satisfied.

The reasons to asses the strength and validity of number of products sold as an instrument rely on two particular aspects. The first concerns the relation between number of products sold and particular portion of costs for distributors. This variable may be linked to costs in distribution and advertising activities directed to physicians. To the extent that remuneration of the agents (i.e. salespersons) or distribution costs are linked to the successful orders and values of sales, this variable should be related to this part of the overall expenses of distribution for the integrated firm and thus with prices.

[38] See for instance Grabowsky and Vernon (1992), Caves, Whinston and Hurwitz (1991) and Scott Morton (1998).
[39] Caves , Whinston and Hurwitz (1991) and De Laat, Windermeijer, Douven (2002).

The second reason is related to the bargaining power of manufacturers with respect to the integrated firms. Producer firms with greater market shares in the specific therapeutic market[40] can sell their products at higher prices. If the main reason of brand loyalty is stickiness in physicians' and patients' behaviour the effect of this variable on the prices for the final consumers may be not directly related to the omitted attributes or unobserved factors that affect demand.

3.3. Effect of the reform

The effect of the reform is measured as increased sensitivity to price induced by generic substitution. The discrete choice model at the base of demand equation assumes that the choice is made by a unique agent. This agent is the couple doctor/patient. Since there is no availability of data on occurred substitution at the pharmacy level the only way to estimate the effect of the reform is to assume that the couple doctor/patient internalizes in their decision the incentives given to the pharmacists. To this aim I compute the incentives stemming from substitution of branded drugs with generic versions as 50% of the difference between actual price of the drug and the maximum price set by the government (i.e. maximum AUP). Thereafter, I assume that this additional difference in prices affects only demand for generics after the introduction of the reform. In order to estimate this additional effect on price sensitivity I construct a dummy variable for the reform , τ_t ,and a dummy for the generics, g_i as follows:

$$\tau_t = \begin{cases} 1 & for \quad t \le 25 \\ 0 & for \quad t > 25 \end{cases}$$

$$g_i = \begin{cases} 0 & for \quad i = 1 \\ 1 & for \quad i = 2-5 \end{cases} \qquad [10]$$

Thus, the demand equation becomes:

$$\ln\left(\frac{\phi_{jt}}{\phi_{1t}}\right) = \gamma_0 (p_{jt} - p_{1t}) + \gamma_1 (p_{it}\frac{A_{it}}{A_{1t}} - p_{1t}) + \gamma_2 \tau_t g_i (\max aup - p_{it}) + \gamma_i + \mu_{it} \quad [11]$$

[40] Other categories of drugs may be characterized by different patterns of consumption or different kind of "agents"; i.e. hospital instead of physicians.

where max*aup* is the maximum price for the branded drug which is constant over time.

If the demand of generics is positively affected by substitution incentives γ_2 is expected to be positive (since the saving is positive).

3.4 Supply side

In order to compute Lerner indexes I assume manufacturers maximize their profits and that their prices are determined in a Nash-Bertrand equilibrium. I consider a profit condition which contains the final price to patients. Since the ex-factory price is not known I use instead the retailer price. By doing this I neglect the double marginalization problem that may occur inside the integrated firm both at wholesaler level and the retailer one. This approach is used in many studies but it may be too restrictive when analysing a reform affecting distribution system. The assumption made amounts to assess that there is perfect competition at all levels of distribution system before and after the deregulation reform. Unfortunately GIP prices are not available and thus it is difficult to formalize marginalization at different levels and especially equilibrium conditions of the bargaining activity between wholesalers and manufacturers in setting the not-restricted GIP (producers selling price).

However, the features of this market make this hypothesis not so restrictive: government regulation limits retailer and wholesaler margins (AUP and AIP). Wholesalers' competition concerns not only selling prices, but also acquisition of the greatest number of pharmacies. After the reform the market for pharmacies is characterized by free entry and by a profit that consists mainly of a fixed sum charged per packages. Margins per package are very low and I assume that competition between pharmacies drives it to zero. Moreover, it is difficult to define market power for distributors: drugs are not a scarce products or a good which can be offered by few exclusive agents. There is no limitation in the number of selling "outlets". Wholesalers and pharmacies are compelled by law to stock and sell all the approved existing medicines. Only producers, exploiting the possible persistence in the consumption of their own good, can set mark-ups. At the distribution level there is no exclusivity or lack of traders that can allow charging the further mark-ups.

Thus, I assume that retailer price reflects manufacturers selling price and also that reform does not change competition on the supply side (i.e. charged margins at the wholesaler and retailer levels and distributors' and pharmacists' strategic behaviour). The Lerner indexes thus computed represent a good approximation of competition between manufacturers.

Thanks to this assumption the expected profit equation, the first order conditions and the price equation are given as follows:

$$\Pi_i(p,...,\gamma) = p_i M\phi_i(A_i,..,p,\gamma) - C_i(q_i,...,\gamma) \quad [12]$$

We assume marginal cost are linear and constant, i.e. $C_i = c_i * q_i = c_i * M\phi_i$.

$$\Pi_i(p,...,\gamma) = p_i M\phi_i(A_i,..,p,\gamma) - c_i M\phi_i$$

$$Mp_i \partial\phi_i(..,..,p,\gamma)/\partial p_i] + M\phi_i(..,..,p,\gamma) - c_i M\partial\phi_i(,,,,p,\gamma) = 0 \quad [13]$$

$$p_i = c_i - \phi_i/[\partial\phi_i/\partial p_i] \quad [14]$$

where M is the size of the market. By using the estimated market shares is it possible to compute the marginal cost.

Since for the logit model $\partial\phi_{it}/\partial p_{it} = \beta_{it}\phi_{it}(1-\phi_{it})$, the marginal cost is:

$$\hat{c}_{it} = P_{it} + \frac{1}{\hat{\beta}_{it}(1-\hat{\phi}_{it})} \quad [15]$$

Finally, the Lerner index is:

$$\hat{L}_{it} = \frac{P_{it} - \hat{c}_{it}}{P_{it}} \quad [16]$$

According to equation (6) the Lerner indexes for generics become:

$$\hat{L}_{it} = \frac{1}{(-\beta_{it})P_{it}(1-\varphi_{it})} \quad [17]$$

with $0 \le \hat{L}_{it} \le 1$ since β_{it} is negative and $\varphi_{it} \le 1$[41].

Lerner index for the branded drug is built in a slight different way.

$$\hat{L}_{it} = \frac{1}{(-\gamma_0)P_{it}(1-\varphi_{it})} \quad [18]$$

The elasticity of price contains only γ_0 . For the branded good, the time term is set equal to zero that is I assume that there is no further time effect for the

[41] In this way there is no need for an intermediate computation of the marginal cost.

branded good. For the branded drug an elasticity of price that decreases over time after the introduction of generics is counter-intuitive. The elasticity and Lerner index of off-patent drug thus varies only due to reduction in the market share. This mechanical adjustment of price is consistent with the usual theory of life-cycle of drugs and the common promotional activity of producers (Caves , Whinston and Hurwitz (1991) and De Laat et al. (2002)) which postulates that manufacturer with old and mature products are not involved any more in big promotional activities. Time does not affect the selling strategy for these products any more since there is no need to inform consumers (i.e. couples physicians-patients) about the existence of the good. The effect of time on price is thus irrelevant and prices are set according to the normal strategic routine. Values of Lerner index for branded drug exceeding unity are set equal to one: this is the maximum value that a Lerner index can take when the price is infinitely higher than the marginal cost[42].

As various study in the literature we are interested in determine how the level of competition vary with the number of entrants. However, since decision of entry is endogenous, it is not possible to regress the Lerner indexes of generics manufacturer on the number of entrants because the resulting coefficient would reflect positive correlation and not causality.

In order to solve this problem I model the decision of entry; as Grabowsky and Vernon (1992) I use the price cost mark-up to explain the number of generic entrants. The number of firm at time *t* is expressed as a function of the maximum level of competition at period *t-1*. The higher the mark-up in the previous period of the generics the more appealing is entrance for other competitors and the more fierce will competition be in the following periods.

The effect of number of firms on Lerner indexes and the entrance decisions are modelled in equation [19] and [20] respectively.

$$L_{it} = \lambda_i + \lambda_1 N_t + u_i \qquad i \neq 1 \qquad [19]$$

$$N_t = k \cdot \max_{i \neq 1}[L_{i,t-1}] + v_{it} \qquad [20]$$

Thus equation [20] becomes:

$$L_{it} = \lambda_i + \lambda_2 \max_{i \neq 1}[L_{i,t-1}] + \eta_{it} \qquad i \neq 1 \qquad [21]$$

$$\lambda_2 = k\lambda_1 \qquad [22]$$

[42] The ratio (p-c)/p converges to one when price goes to infinite.

$$\eta_{it} = u_{it} + \lambda_1 v_{it} \qquad [23]$$

where $\max_{i \neq 1}[L_{i,t-1}]_{it}$ is the maximum lagged Lerner index between generic drugs, λ_i are fixed effect and $u_{it} + \lambda_1 v_{it}$ is a mixed noise term.

Equation [21] is estimated with fixed effect technique. Since k is expected to positive and λ_1 to be negative, λ_2 is expected to be negative. Thus, a negative sign of λ_2 will provide evidence of competition between entrants.

The use of fixed effects with lagged dependent variables could bias the estimates since the lagged dependent variable is a predetermined regressor[43] but is not strictly exogenous.

By estimating equation [21] with random effects technique I will also check whether the λ_i individual effect may be considered non estimable and therefore may be included in the composite error term $\eta_{it.}$

4 Data

The dataset is provided by the Norwegian Statistical Association. It contains quarterly observations for 97 different molecules for a total of 1422 different packages[44]. Observation period starts in the first quarter of 1995 and ends in the third quarter of 2002. For each molecule and each quarter the dataset contains sales values, number of units sold, number of doses sold, price per unit, price for DDD[45]. For each molecule there is a unique atc code. Each package (same molecule but different package) has a different identification number. The dataset contains also information on the single package like for instance the number of pills, type of package (table, glass, etc.). Drugs are distinguished according to the nature of their importation, i.e. if they are direct import or parallel import. The dataset contains also fragmentary information about registration date of the drug.

Using this dataset I have calculated the market shares as quantity of the firm divided by total quantity. As quantity I use the number of doses per day sold by each firm. Therefore also the price is adjusted in order to refer to the single dose.

[43] Strictly exogeneity requires that $E[L_{it}\eta_{is}]=0$ for all s and t. Instead in this case is $E[L_{it}\eta_{is}] =0$ for $s>t$ but $E[L_{it}\eta_{is}]\neq 0$ for $s<t$.

[44] For each molecules there are different packages that differ for number of pills or doses.

[45] Defined daily doses.

Since I do not consider the products sold by the same firm as different, apart from some little differences in the packages and quantity of pills the price is a weighted average of the prices of different packages sold by the same firm (the weights are the quantity of each product divided by the overall quantity sold by the same firm).

The dataset contains different concentrations of enalapril (2.5 mg,5 mg, 10 mg and 20mg). I assume the time the branded product entered the market is 1995 that is in the first period of the dataset.

5 Estimation results

The demand equation [11] is estimated by using fixed effect technique. The observations used are those after the entry of the first generic.

Estimates are computed by STATA. The sum of the fixed effects is normalized to zero and only one constant is estimated. The estimates are shown in Table 2. The second and the third columns show estimated coefficients and standard errors for equation [11] without instruments and with instruments respectively. The instrumented variable is the difference in prices. The instrumental variables are the differences in the number of products sold by the firm in the same therapeutical market (enalapril excluded) and the price difference in the market for enalapril 5 mg. Number of observations are 56.

Dependent variable: $\ln(\varphi_{it}-\ln \varphi_{1t})$	Coefficients	Estimates Model 1	IV-estimates Model 2
	γ_0	-1.3406 (0.2881)	-1.8284 (0.3972)
	γ_1	2.2394 (0.4217)	2.4439 (0.4460)
	γ_2	-0.0320 (0.0144)	-0.0294* (0.0152)
	Constant	5.7176 (2.2145)	5.3271 (2.3470)
R-sq: within		0.7964	0.7731
Between		0.78963	0.7311
Overall		0.6841	0.6522
F(4,25)		24.42	22.67

Table 2. Estimates of equation (11), without instruments (Model 1), and with instruments (Model 2), with fixed effects technique. Standard errors in parentheses. *Not significant at 5% level

The price coefficient (γ_0) has the negative sign and it is significant. The coefficient γ_1 on the price-time variable is positive and significant. This means that a negative difference in the interaction terms increases in absolute terms the (negative) difference of the logarithm of market shares.

The γ_0 coefficient estimated without any instruments is smaller. As was expected this fact seems to suggest that there exist a problem of endogeneity not completely accounted for by the use of fixed effects estimation.

The coefficient for the reform, γ_2 , has an unexpected negative sign and in the instrumented estimation is insignificant at 5% level. This sign seems to suggest that the reform did not work in the expected manner and that it was too weak in stimulating substitution at the pharmacy level.

However, since this analysis is based on aggregate data, it may also be that the additional term $\gamma_2 \tau_t g_i (\max aup - p_{it})$ captures a lower sensitivity of generic demand with respect to prices when the reform is active. In the periods immediately after entrance consumers (i.e. couple physicians' doctors) which are

more sensitive to price switch to generics attracted by the lower prices[46]. As a result it might be that during the first periods aggregate demand is much more sensitive to generic prices than in the second period[47]. Thus, there is the risk that these estimates are biased because of heterogeneity and because of the short period of time elapsing between entry of competitors and the beginning of the reform.

However, I claim that if the reform had been able to produce strong incentives to substitution the γ_2 coefficient would have been positive. The reason of the failure of the reform is that since substitution was non mandatory. Thus, it did not provide pharmacists with sufficient power and incentives to substitute branded with generic. As a result, the gains stemming from substitution were uncertain since both doctors and patients were able to forbid it. Therefore due to the uncertain nature of the gains from substitution, vertically integrated firm could decide not make strategic efforts and not to invest in activities encouraging substitution. Thus, manufacturers of branded drugs have decided to keep the prices higher.

A further reason of the failure of the reform, which is not formalized in the supply side of the model, may be related to the trading and bargaining activities between wholesalers and manufacturers. Manufacturers' selling price is not restricted and thus wholesalers can negotiate it. It seems quite reasonable that since branded drugs represent the largest part of the market shares, wholesalers can obtain a better margin on these products at least in the form of quantity discounts. That is, it might be that manufacturers of branded drugs, willing to maintain the predominance of their products, share their margins with the distributors, keeping the final price to consumers the same[48]. Thus, the vertically integrated firm will prefer to sell drugs at higher AUP and recommends this selling strategy to all its members.

[46] Frank and Salkever (9912) claim that demand for drugs consist of two segment: one that is high sensitive to price and another one which is instead price insensitive. In their paper they explain why in the U.S. market of some drugs price of the original products increases after entrance of generic versions.

[47] It may also be that hospital pharmacies are more clever in substituting branded drugs with generic versions; this is another sources of heterogeneity that may explain the higher sensitivity of demand with respect to generics prices during the first periods.

[48] Unfortunately, as already mentioned, wholesalers' purchasing prices are not available and as a result the equilibrium assumption used can be too restrictive.

The graph shows the Lerner indexes according to equations [18] and [19] over time for the branded drug. Lerner indexes are computed using the elasticities estimated with instrumental variable techniques an neglecting the additional price effect on generic demand due to the reform.

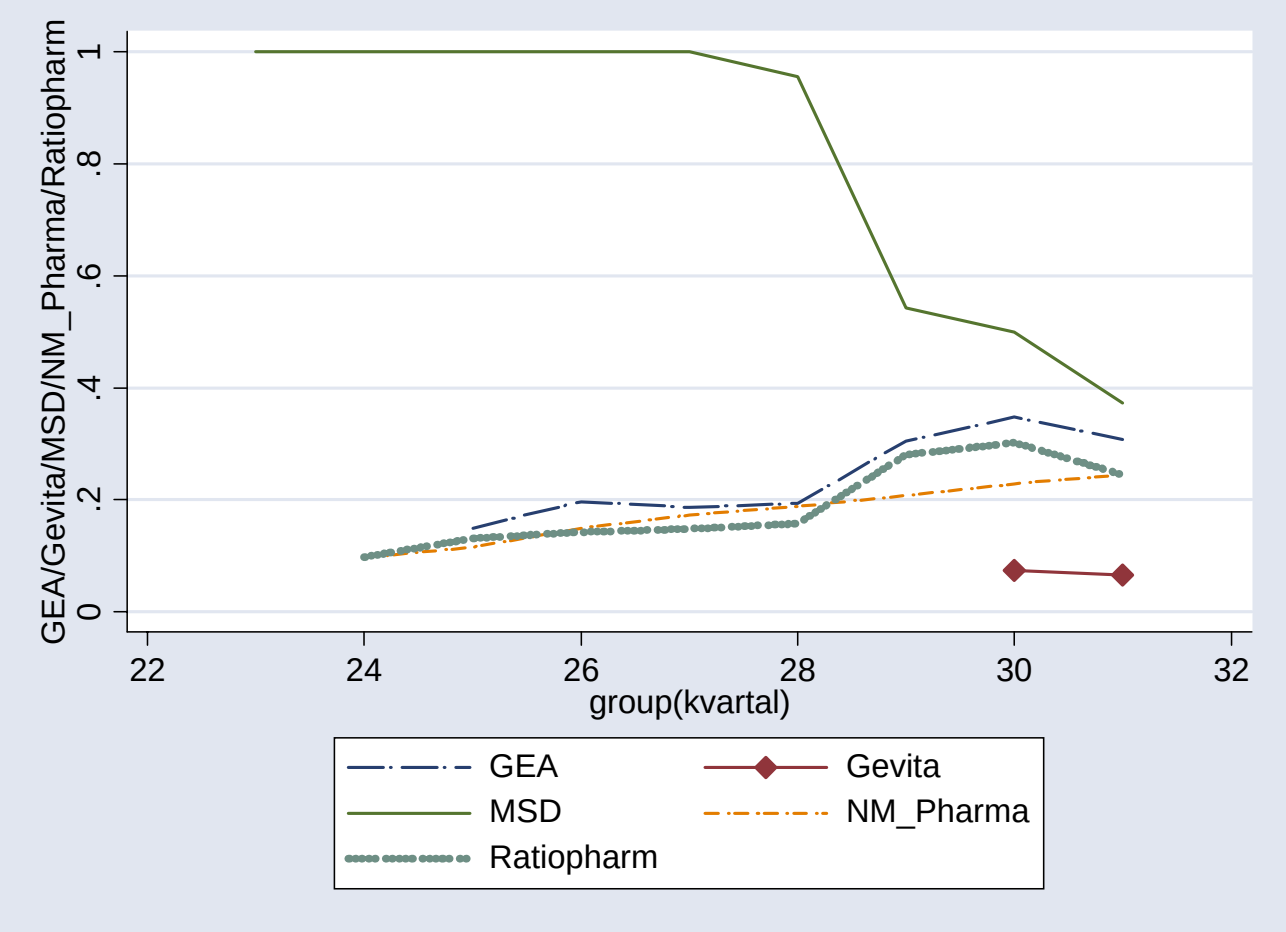

Figure 3: Lerner indexes of enalapril 2.5 mg. Source: author's computation.

As can be seen from Figure 3 1 the Lerner index for the branded good has the highest value and it decreases over time with the introduction of the generics. Instead, the lerner indexes for generics increase over time due to both the raise of their respective market shares and to the positive time effect that makes the elasticity with respect to price smaller. Thus, the level of loyalty or trust in the product increases over time and consumer get accustomed to the product and less sensitive to its price.

The next step is to compute the effect of number of entrants on the level of competition, that is the estimation of equation [21] with fixed effects and random effects.

Dependent variable: L_{it} $i \neq 1$	FIXED EFFECT Coefficients	RANDOM EFFECT Coefficients	Number of observations: 25
λ_2	-.1005225 (.0387798)	-.0997506 (.0380338)	Number of groups: 5
Constant	.2285969 (.0193325)	.2104886 (.0433284)	
R-sq: within	.073678		
Between	.05983217		
Overall	.6021479		
F(3,20)	4.46	.	

Table 3: Estimates of equation [21] with fixed and random effect technique in columns (2) and (3) respectively.

Notes: standard errors are in parenthesis. All estimates are significant at 5% level.

Estimations with random and fixed effects yield similar values for all the coefficients. Hausman's specification test rejects the null hypothesis of significant difference between the two estimators. The coefficient of maximum lagged Lerner index is negative suggesting the presence of competition between manufacturers. Thus, a high level of generics' market power in previous period induces a greater competition in prices aimed at increasing market shares.

6 Conclusions

The paper examines a case of intra-molecular competition and analyzes the effect on demand for generics of a non-mandatory substitution reform aimed at

encouraging switches from branded drugs to generic versions. The case of enalapril 2.5 is examined.

Demand for generic and branded drugs is modelled using a discrete choice approach. In order to distinguish these therapeutically equivalent products, the time spent by each firm in the market is interacted with the price of drugs, and thus introduced in the characteristic differentiation space. Estimation of demand parameters, even with aggregate data and just two regressors (time and price) provides relatively good results in terms of estimated price elasticities. Time is thus allowed to affect price coefficient and demand for generics. Fixed effects technique is used to control for time invariant unobservable attributes. The presence of time varying unobservable attributes calls for the use of instruments, which are created using information available in the dataset. The gains from substitution are introduced in the demand equations to verify the effect of the reform: their effect is found to have an unexpected negative impact on generic demand and in same cases an insignificant effect.

Estimated price elasticities, together with the assumption of Bertrand-Nash equilibrium are used to construct the Lerner indexes. These indexes are then taken as a measure of market power for producers and are used to verify competition between generic producers and the results show that new entrants compete between themselves.

A further improvement of the analysis would require the availability of the more detailed data (i.e. microdata). Willing to better define the demand side, the information on the occurred substitution at pharmacy level is needed. On the supply side, more information on manufacturers' and wholesalers' selling prices is needed in order to give a better approximation of the equilibrium conditions and to address explicitly the double marginalization problem after the pharmacy ownership deregulation.

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