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CHANGES IN DRUGS' PREFERENCES DUE TO THE INTRODUCTION OF NEW GENERIC MEDICINES

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Joana Maria Figueira

January 8th, 2020

Abstract

The purchase of generic drugs has been increasingly encouraged by Governments, as a way of reducing health costs. However, their acceptance by consumers is not that straightforward and it has been seen some resistance associated with lack of information and some other factors, including loyalty to previously used branded products. Thus, this dissertation aims to study the consumers' preferences over generic drugs, by clarifying some of these speculations while trying to check whether the data confirms these reasonings.

This was possible by exploring a rich database from the Portuguese National Association of Pharmacies, which includes very detailed information of each medicine sales at pharmacies in Portugal.

The results show that when introducing one more equivalent generic medicine in a group, the individual share of each drug decreases, although the generic ones suffer a higher decrease in their shares. Additionally, generic drugs tend to have a lower individual share than the equivalent branded medicines.

Afterwards, over a short time, even on year-on-year comparisons, the shares of generic drugs tend to increase, opposed to the shares of branded products, which indicates a relatively fast change in preferences, based on the speed of information spreading and reputation building.

Although in the analyzed sample people buy more generic than non-generic drugs, it is shown that if one more generic medicine and the correspondent proportion of branded drugs is introduced such that the proportion of equivalent generic drugs remains unchanged, the branded products will immediately capture a higher market share.

Keywords: consumers' preferences; generic drugs; drugs market.

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Resumo

A compra de medicamentos genéricos tem vindo a ser encorajada pelos Governos, como forma de reduzir os custos da saúde. No entanto, a sua aceitação por parte dos consumidores não é fácil, havendo alguma resistência associada à falta de informação, mas também a outros fatores, como a fidelidade a medicamentos de marca anteriormente utilizados. Assim, esta dissertação tem como objetivo estudar as preferências dos consumidores relativamente a medicamentos genéricos, tentando clarificar algumas destas especulações e verificar se os dados as confirmam.

Para isso, explorou-se uma base de dados fornecida pela Associação Nacional de Farmácias, que inclui informações detalhadas das vendas dos medicamentos nas farmácias em Portugal.

Os resultados mostram que ao introduzir mais um genérico equivalente no seu grupo, a quota de cada medicamento individual diminui, apesar de serem os medicamentos genéricos a sofrer uma maior redução. Adicionalmente, medicamentos genéricos tendem a ter uma quota individual menor do que os medicamentos de marca equivalentes.

Seguidamente e ao longo do tempo, numa comparação homóloga, as quotas dos medicamentos genéricos tendem a crescer contrariamente aos não-genéricos, o que indica uma alteração relativamente rápida nas preferências, com base na divulgação de informação e crescente reputação.

Apesar de se observar que são vendidos mais genéricos do que não-genéricos na amostra utilizada, verificou-se que se introduzirmos simultaneamente um medicamento genérico e a respetiva proporção de medicamentos de marca de forma a que a proporção de medicamentos genéricos equivalentes não se altere, os de marca irão capturar imediatamente uma maior quota.

Palavras-chave: preferências dos consumidores; medicamentos genéricos; mercado dos medicamentos.

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1 Introduction

The drugs market has been suffering many changes during the last decades. Not only because new medicines and therapies have been discovered, contributing to the increase in the number of treatments available, but also because when the patents of the original drugs expire, progressively new equivalent drugs have been introduced in the market.

In this thesis we will explore how the market shares of equivalent medicines change when more generic drugs are introduced, by using data on the way consumers made choices when confronted with the option of buying a generic or a branded medicine. Firstly, this study considers the individual drug shares into their homogeneous groups, which allows to test if each generic drug has higher shares than branded products as well as consumers' tendency to diversify between equivalent medicines that may be related to some socioeconomic factors. Additionally, the aggregated shares of all the equivalent generic drugs are also taken into consideration, in order to be possible to study preferences for generic drugs as a whole which, once more, may depend on some socioeconomic factors, too. Nevertheless, opposed to Aronsson et al. (2001), the market shares will be computed using quantities, specifically the number of units purchased, instead of the market shares in terms of money spent.

In order to do this, a database provided by the Portuguese National Association of Pharmacies (Associação Nacional de Farmácias - ANF) is going to be used, which includes detailed information of the drugs sales in volume and in value, in each Portuguese county between the years 2013 and 2017. Some characteristics of the drugs are also part of the database, such as if each drug is a generic or a branded product, if a medical prescription is needed to buy them, their reimbursement percentage from government or their classification about the organ or system of organs over which they act. It is expected that consumers' preferences are mainly influenced by price differences and availability of equivalent drugs but also by some socioeconomic factors. However, the effects of these factors is not easily predicted since, for instance, higher levels of education may lead to more generic acceptance whereas higher income may lead to a preference for a branded product previously used and these two variables correlate and it is not possible to identify *ex ante* which one will dominate.

By crossing it with a group of socioeconomic variables collected in order to characterize each county, it will be possible to have a perception of the socioeconomic conditions that may influence consumers' preferences, apart from price differences and availability of equivalent drugs.

After that, two main econometric regressions will be performed to understand how the individual shares of the individual drugs, either generic or brand-name ones, are affected by the introduction of new equivalent generic drugs as well as by consumers' socioeconomic background. Additionally, this study tries to find if Portuguese patients prefer generic drugs to non-generic ones, taking into consideration price differences and again their socioeconomic characteristics. Since the government has been introducing new policies to incentivize the con-

sumption of generic drugs, it will also be possible to test if these have been effective.

It was possible to conclude that individual generic drugs have lower shares than the equivalent branded ones. Moreover, when generic drugs are introduced, the individual share of other equivalent medicines decreases, although the generic medicines are the ones who lose more. Regarding the preferences for generic medicines as a whole, it was possible to verify that the municipalities with more unemployed people are the ones where more generic drugs are sold but, on the other hand, there seems not to be significant differences in terms of the preferences for generic drugs between young and old patients. Furthermore, the higher the price differences between generic and non-generic drugs, the higher the preferences in favor of the first ones. Finally, it was concluded that if one new generic drug is introduced simultaneously with the introduction of the respective proportion of equivalent non-generic drugs, maintaining the proportion of equivalent generic drugs available, the branded products capture immediately a higher share.

Consumers choose the goods they want to buy not only according to price but also taking into consideration the quality of the product as well as some of its characteristics and attributes. (Asker and Cantillon, 2010; Chetty, Looney and Kroft, 2009). Furthermore, sometimes it is not just the characteristics and price of one product itself that matters for the consumer choice, since they also consider how a good compares with other similar ones (Bordalo, Gennaioli and Schleifer, 2013).

In fact, changes in the households' consumption bundles are frequent and can be seen during recessions and financial crises (Nevo and Wong, 2019; McKenzie and Schargrodsky, 2011) as well as in the different phases of the business cycle (Jaimovich, Rebelo and Wong, 2019). Moreover, when new similar products are introduced in a market there may be an incentive to adjust the consumption bundle, which may happen to be different from one household to another due to the existence of some idiosyncratic factors.

Comparisons between goods are not always that simple, and neither is the possibility to have a clear idea about the characteristics of the product. This is particularly true for goods which one must buy and experiment in order to make a judgement and have an informed opinion about it. Take experience goods, which incorporate some health products and drugs, as an example. The positive effect or the side effects of a specific drug are only observable after taking it and those effects can take long to develop. Therefore, it may be difficult to evaluate the quality of the product just by looking at its label or price. Hence, some beliefs may emerge related to products but, unfortunately, these can sometimes be biased and affect negatively the choice and optimal use of drugs. (Baicker et al., 2015).

The uncertainty regarding the use of medicines arises from many factors but, in the last few years, more equivalent drugs have been introduced with the same characteristics of the previously existent branded ones and they have been provoking different reactions in patients' behavior. A generic drug, as it is called, is a "medicine which has the same qualitative and quantitative composition in active substances and the same pharmaceutical form as the reference

medicine, and whose bioequivalence with the reference medicine has been demonstrated by appropriate bioavailability studies” (WHO Collaborating Centre for Pharmaceutical Pricing and Reimbursement Policies, 2019)). Notice, however, that, due to the avoidance of high costs in research and development, generic drugs can be traded at a lower price, allowing for a reduction in the overall health budget.

On one hand, many governments, including the Portuguese one, have adopted new policies that incentivize the prescription, dispensing and consumption of generic drugs. Electronic prescription software, for instance, has become a common feature, helping physicians to have immediate access to the list of the cheapest generic drugs when prescribing. In Portugal, for example, it is mandatory since 2012 to prescribe medicines using only their International Non-proprietary Name (INN), allowing the patient to choose whether to buy the generic or brand medicine, in the pharmacy. Additionally, governments tend also to assign higher reimbursements to generic drugs. Note the case of France, where the patient charge is almost zero when it comes to generic drugs. In many countries, it is also common to see media campaigns that have also been prepared by the national competent authorities (Barros and Nunes, 2010; Dylst et al., 2013).

On the other hand, the low prices may be associated with low quality products by consumers (Monroe, 1973; Bagwell and Riordan, 1991). In some extreme cases, there are even some associations of generic medicines with counterfeit drugs due to the price difference, as shown by Håkonsen and Toverud (2011), although generic medicines are also subjected to the same safety and equivalence tests in order to get the authorization to be traded in the market.

Notwithstanding, generic medicines seem not to have the same acceptance as the original brand-name products. Hence, many studies have been done around the world in order to try to understand what the main reasons for a risk averse behavior from consumers toward generic drugs are. Some authors found that some people are still unaware of the existence of equivalent generic products with lower prices and when asked by the pharmacist if they want to buy the generic one, they refuse, arguing that they need to confirm with their physicians whether the generic and the brand-named products are equivalent (see Gill et al., 2010; Håkonsen et al., 2009; Håkonsen and Toverud, 2011; Heikkilä et al., 2007). Previous positive experiences with brand-name product and the idea that if the doctor did not mention the specific name of the generic product it means that the other is better can also contribute to the resistance against the purchase of generic drugs (Heikkilä, et al., 2007; Toverud et al., 2011). In addition, small aspects that at first sight may seem irrelevant, like the color or shape of generic drugs differing from the original branded product, may cause some unease feelings in patients that may even misuse these drugs, resulting in a reduced effectiveness of them (Ching, 2002; Roman, 2009).

Since the doctors’ and pharmacists’ opinions seem to be a determinant factor to the acceptance for generic substitution by patients (Hassali et al., 2005; Shrank et al., 2009), some other studies have been conducted in order to try to understand what these professionals think about it. Shrank et al. (2011) argue that older physicians have significantly worse opinions

about effectiveness of generic drugs than the younger ones, but all of them actually seem to be influenced by their colleagues (Haug, 1997, Thompson, 1997; Saxell, 2014). However, Bronnenberg et al. (2015) also concluded that physicians are more likely to accept generic medicines than the standard patients.

Furthermore, as described in the beginning to be one of the testes performed in this work, it is expected that consumer's preferences for generic drugs depend also on their socioeconomic background. Farfan-Portet et al. (2012) found that consumers that live in small areas are more likely to accept generic substitution for the majority of the drugs they analyzed, as well as people that benefits from guaranteed minimum income. Moreover, it seems that higher education tends to increase the acceptance of generic medicines (Dylst et al., 2013; Quintal and Mendes, 2012; Vallès et al., 2003). Notice, however, that better socioeconomic conditions may have different impacts in consumers' preferences. On one hand, people with higher income may be more reluctant to accept generic drugs but, on the other hand, people with higher education levels may be more willing to accept them. In some cases, when these two factors are much correlated with each other, it may not be possible to identify them clearly. Still, there are different results about the impacts of age and gender on the purchase of generic drugs: Figueiras et al. (2008) concluded that there are no significant differences between distinctive ages or gender, whereas Himmel et al. (2005) and Heikkilä et al. (2007) concluded that people under 60 years old tend to accept generics easily.

Chronic diseases have also been shown to have different impacts. Himmel et al. (2005) found that patients tend to be loyal to the brand-name medicine that have been using previously but Shrank et al. (2009) argue that some patients prefer to change to a generic drug in order to spend less money. However, Stewart et al. (2010) and Figueiras et al. (2008) found that people tend to accept more generic drugs when facing minor diseases, such as a cold or the flu, but tend not to risk on changing to a generic medicine when facing heart problems, diabetes and some other major diseases.

Despite everything, consumers also mention money savings as one of the most important reasons for buying generic medicines (Heikkilä et al., 2007; Himmel et al., 2005) and the fact is that there has been an increase in generic medicines sales in many countries over the last few years. Consequently, it triggered the interest of some researchers to study the effects of the competition that still arise when new generic products are introduced in the market. Grabowski and Vernon (1992) concluded that shortly after a patent expires, generic drugs can capture a large market share due to the difference between the price of the two products. Moreover, some other authors have studied the change in the brand drugs price after the introduction of equivalent generics and here the results diverge (see Caves et al., 1991; Frank and Salkever, 1997; Hudson, 1992). Aronsson et al. (2001) studied the impact of generic medicines competition on the market shares of the branded drugs, analyzing micro data from the Swedish drug market, which is regulated by a Reference Price System since 1993. However, by assuming that the demand is inelastic relatively to price, they focus more on the changes of market shares caused

by price differences and not by differences in quantity demanded.

The drug market in Portugal has also been changing during the last years. Generic drug sales have also been increasing and the forecast is that they will continue to increase in the future, as argued by Barros et al. (2015). Even though the price of each medicine that requires a medical prescription is previously authorized and regulated by the National Authority of Medicines and Health Products (INFARMED, I.P.), leading to equal prices of each medicine in the whole country, the preferences for generic drugs show a large variation between Portuguese municipalities, which are the focus of this dissertation.

After this introduction, an overview on the characterization of the Portuguese drugs market will be presented in Section 2, with a brief analysis of the Portuguese law. After that, Section 3 will describe the dataset and methodology used in this study and in Section 4 the two econometric regressions will be explained and commented: the first one looks specifically for the individual share of each medicine in comparison to the other equivalent drugs, while the second regression takes into consideration the share of all the equivalent generic products. Section 5 will present the same analysis but assuming the special reimbursement regime existent in Portugal. A quick analysis of the econometric model used will be made in Section 6 and Section 7 concludes by discussing some of the main results obtained in this dissertation, presenting the limitations of the analysis made and some possible suggestions of work to develop in the future.

2 The Portuguese Drugs Market

The Portuguese law has a very well-defined framework according to which the Portuguese drugs market is established. The National Authority of Medicines and Health Products (INFARMED, I.P.) is an institute integrated in the indirect administration of the Government and reports to the Health Ministry. Its role is to evaluate, authorize, regulate and control the human medicines and health products in the Portuguese market. In consonance with the Decree-law no. 176/2006 of August 30th, the INFARMED has the responsibility to manage the database that includes all the medicines with authorization to be traded in Portugal. In order for the producer to be a market authorization holder, it has to present a detailed requirement directed to INFARMED, including the results of the pharmaceutical and clinical tests made to the medicines.

As established by article no. 113 of the same Decree-law, the drugs can be classified as medicines subject to medical prescription or not, depending on the risk that they may cause to patients when administrated without medical vigilance, when taken in certain quantities and some other aspects. The latter are usually not reimbursed by the Government, except for some specific cases. However, these can be bought in a great variety of shops apart from pharmacies, such as supermarkets and service stations but, in accordance with article no. 1 of the Decree-law no. 238/2007, that was changed by the Law no. 51/2014, they are not reimbursed. Apart from that, the prices of medicines not subjected to medical prescription sold outside pharmacies are not controlled, except for those subjected to a maximum price.

The maximum price regime was assigned to the medicines requiring medical prescription as well as to the medicines not requiring it but that are reimbursed by the Government, by the article no. 3 of the Decree-law no. 112/2011 that was changed by the Decree-law no. 34/2013. However, from 2015 onwards, the Decree-law no. 97/2015 defines that the medicines covered by the maximum price regime should be specified in a government ordinance, which in case are defined by the Ordinance no. 195-C/2015, article no. 2, but remain the same. In those cases, the market authorization holder may charge lower prices but never higher prices than the defined maximum price. The maximum price is defined by INFARMED since 2012 (according to the Decree-law no. 152/2012, article no. 2, that introduces changes to the Decree-law no. 112/2011, and was updated by the Decree-law no. 97/2015).

There are two reimbursement regimes in Portugal, as established by the Decree-law no. 48-A/2010 from May 13th, in the version of the Decree-law no. 106-A/2010 from October 1st. Hence, the general regime has four reimbursement categories defined, A, B, C and D, which are reimbursed at 90%, 69%, 37% and 15%, respectively. The medicines are distributed to these categories in accordance to a government ordinance, updated in 2015 by the Ordinance no. 195-D/2015, article no. 2. On the other hand, there is the special regime with higher percentages, that is applied to people with low income, such when the yearly income is lower or equal to fourteen times the guaranteed minimum monthly income, or even to medicines used to treat certain diseases specified in a government ordinance (see articles no. 19 and 20 from the Appendix of the Decree-law no. 48-A/2010).

When there is at least one generic medicine with the same qualitative and quantitative composition in terms of the active substances, pharmaceutical form, dosage and route of administration, homogeneous groups are formed and published by the INFARMED, in accordance to the Decree-law no. 103/2013, updated by the Ordinance no. 195-B/2015.

Moreover, it is approved by the government members the reference price for each homogeneous group, previously proposed by the INFARMED. Since 2010 the reference price is computed as the price of the generic product with the highest maximum price in each homogeneous group, and it will be over this reference price that the government reimbursement will be applied (article no. 25 from the Appendix of the Decree-law no. 48-A/2010) However, from 2015 onwards, the reference price is computed as the average of maximum prices of the 5 generic drugs with the lowest prices (article no. 19 of the Decree-Law no. 97/2015). Therefore, the maximum government reimbursement for the general regime of drugs covered by the reference price system will be equal to the percentage of the respective category times the reference price (article no. 28 of the Appendix of the Decree-law no. 48-A/2010).

It is worth mentioning that, since 2012, the medical prescription must be done using not the name of the drug brand, but the International Non-proprietary Name (INN) of the active substance instead. However, the physician may just in a few cases specify the brand of the medicine that should be used by the patient, such as when the drug will be used to continue a treatment already started (Article no. 2 of the Law no. 11/2012). When buying the medicine

at the pharmacy, each patient should be informed about other existing equivalent drugs and the ones that are reimbursed by the government. It is mandatory that all the pharmacies have at least 3 of the 5 generic drugs with the lowest prices for each homogeneous group and they should sell the one with the lowest price to patients. Nevertheless, the customers have the right to choose which one they prefer among the ones with the same INN, pharmaceutical form and dosage according to the medical prescription (Article no. 3 of the Law no. 11/2012).

One should also note that in Portugal the medicines are also classified according to their pharmacotherapeutic classification. This classification has a direct correspondence with the Anatomical Therapeutic Chemical Code (ATC code) which is controlled by the World Health Organization (WHO), specifically the Collaborating Centre for Drug Statistics Methodology. This code is internationally used and it groups the medicines according to the organ or system of organs over which the drugs act in the body, as well as their therapeutic, pharmacological and chemical properties. One can check this correspondence by reading, for instance, the Order of the Secretary of the State for Health no. 4742/2014, of March 21st. Another aspect of the ATC code is that it is composed by 5 different levels and the first one (the first letter of the code) relates to the anatomical main group.

3 Data and Methodology

3.1 Sample selection

In order to study the consumers' preferences, a database that includes the sales of each drug aggregated in municipalities was used. It was kindly made available by the Portuguese National Association of Pharmacies (Associação Nacional de Farmácias - ANF) for this study and contains monthly data on the sales in value and in volume between the years 2013 and 2018, as well as some variables that characterize each drug, such as if the drug is a generic one, its homogeneous group, its ATC code and its official reimbursement by the National Health Service (NHS). However, only about 82% to 85% of the Portuguese pharmacies report their sales to ANF, which means that it was not possible to have access to the whole Portuguese drug market. As a consequence, the sample includes only 305 of the 308 counties, with São Vicente, Lajes das Flores and Corvo not being represented.

Simultaneously, a group of socioeconomic variables that allows for the characterization of each Portuguese county was also collected from the Portuguese National Statistics Institute (Instituto Nacional de Estatística - INE). However, these variables were only available for counties with an annual periodicity and up to the year of 2017. Consequently, in order to cross the two databases, it was needed to convert the monthly data on drug sales into annual data. Moreover, the period of the analysis was reduced to the years 2013 to 2017 in order to be possible to characterize the counties (See Table 1 for a description of the data selection). Regarding the variables related to the level of education, such as the percentage of people more than 14 years

Table 1: Number of observations during the data selection process

Description	Observations	%
Initial number of observations	13,192,020	100
Keeping only the products whose characteristics were available	13,190,496	99,99
Eliminating health products (e.g. cosmetics and medical devices)	11,507,340	87,23
Keeping just the medicines that require medical prescriptions	11,494,416	87,13
Eliminating the observations with sales in volume equal to zero	7,511,902	56,94
Eliminating sales for 2018 (since some socioeconomic variables are not available)	6,337,866	48,04
Keeping only the medicines that belong to a homogeneous group at least on one period	4,203,155	31,86
Crossing with the socioeconomic variables and imputing each drug code to each county for every period	11,427,740	86,63
Keeping only the medicines for which at least one medicine of their homogeneous group was sold (Tables 5 and 10)	9,620,593	72,93
Keeping just one observation for each homogeneous group (Tables 6 and 11)	933,919	7,08

old that completed only the high-school, that have an academic degree or that did not complete any educational level at all, are only available at a county level from the Censos database. The last data collection is of 2011, two years before the first year of our database, but these variables were still introduced since they are considered as the best proxy for the educational level of the population possible. Hence, all the socioeconomic variables change annually, except for the education related ones that were considered constant over the whole period. See Table 2 for a description of the socioeconomic variables. Notice that one observation is the detail of one medicine in a county, for a given year.

Hence, the used database included the sales of each drug in each county, but then selecting the drugs was necessary. Firstly, only the drugs that require a medical prescription were considered since these are the ones that have their prices controlled. Additionally, because it is of our interest to study the preference for generic drugs, only the medicines that have at least one equivalent generic drug were considered, ignoring all the medicines without generic equivalents. Thus, only the drugs that belonged to one homogeneous group at least during one period were kept.

The homogeneous groups are one crucial aspect of this analysis. In fact, all the shares will be computed considering the number of units sold of the individual medicines or the number of units sold of all the generic drugs in the total of units sold in the respective homogeneous group. The reason for this is that, as previously mention in Section 2, one homogeneous group includes all the equivalent drugs in terms of the qualitative and quantitative composition of the active substances, pharmaceutical form, dosage and route of administration. Therefore, the analysis will be performed inside of each homogeneous group, which identifies the equivalent drugs. It is worth mentioning that the optimal unit of measure would be the Defined Daily Dose

Table 2: Socioeconomic variables

Variable	Description
<i>youngpeople</i>	Percentage of resident population less than 25 years old
<i>oldpeople</i>	Percentage of resident population more or equal than 65 years old
<i>totalpop</i>	Average of the total resident population
<i>pharmpc</i>	Number of pharmacies per capita
<i>minincome</i>	Percentage of the resident population that benefits from the guaranteed minimum income
<i>unemp</i>	Percentage of the adult resident population enrolled in the Employment and Professional Training Institutes
<i>density</i>	Population density
<i>income</i>	Average basic remuneration by worker
<i>noeduc</i>	Percentage of resident population with more than 14 years old with no education
<i>highsch</i>	Percentage of resident population with more than 14 years old with only the high school completed
<i>acdegree</i>	Percentage of resident population with more than 14 years old with

Notes: This Table reports the socioeconomic variables taken into consideration in the cluster analysis. All of them, except for the totalpop, were also included in the regressions analyzed in Section 4.

(DDD) which is defined as the “average maintenance dose per day for a drug used for its main indication in adults” by the WHO (2019), since it would allow us to control for the fact that one person might take one pill with 500mg or two pills with 1g of the same active substance. However, DDD was not available in the ANF database and so this analysis focus on the shares in units (for instance, pills and ampoules).

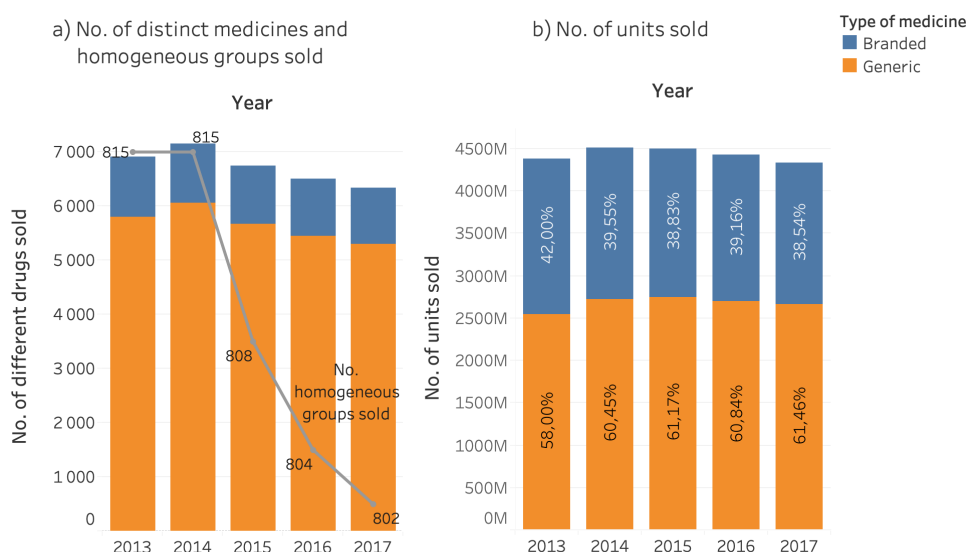
Additionally, it will be computed the out-of-pocket price per unit for each medicine so as to consider the differences in their prices. Thus, the unitary out-of-pocket price considered is calculated as the difference in the price per unit of one drug and the unitary price of the equivalent drug with the lowest price in their respective homogeneous group. Moreover, the unitary prices previously mentioned are not the total price of the medicines but only the part actually paid by consumers.

3.2 Descriptive statistics

Just by using some simple descriptive statistics, it was possible to identify some facts. The number of medicines sold has been decreasing from 2013 to 2017, in about 800 homogeneous groups, as shown in panel a) of Figure 1. Moreover, the market share of generic drugs in units sold has been slightly increasing, despite the fact of the total number of units sold of all the medicines has been decreasing (see panel b) of Figure 1).

There can also be seen some differences in the consumption patterns across the different regions of Portugal. In a first analysis, the Portuguese counties were organized into 5 groups according to their socioeconomic characteristics (see Figure 2 for a geographical localization of

Figure 1: No. of units sold (all medicines)

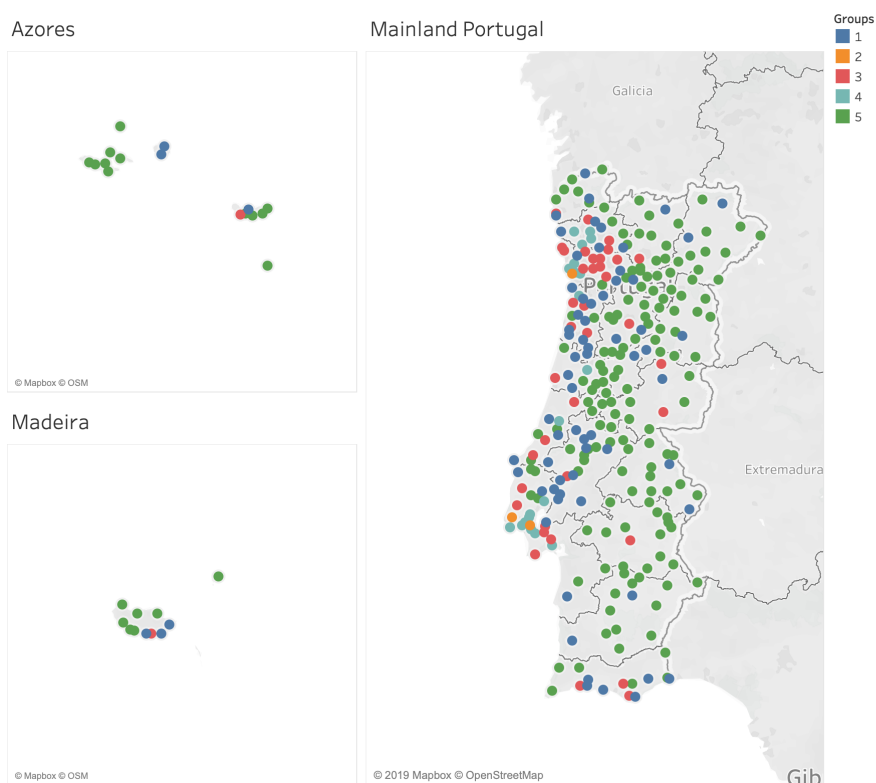


Notes: Panel a) reports the number of different medicines that are subjected to medical prescription sold in each year, in bars. In grey, in the same graph, the number of homogeneous groups among which the drugs sold are included is represented. Panel b) reports the number of medicines sold in each year, in total of units, and the proportion of generic and branded products are shown inside each bar.

the counties belonging to each group), using a k -means clustering method, and the coast ones immediately stood out from the interior municipalities, with a special highlight of the counties from the Lisbon and Porto metropolitan areas. (The list of the counties by group can be found in the Appendix). The group number 2 that includes only the counties of Lisbon, Sintra and Vila Nova de Gaia is the one with a higher level of socioeconomic conditions, opposed to the group number 5 that includes 174 counties mainly from the interior of the country where there is a higher percentage of old population, as well as a higher percentage of people with no education or that benefit from the guaranteed minimum income. See Table 3, which shows the relative characterization of the groups.

It can be recognized that the third group is the one with more intermediate values for the majority of the considered variables. On one hand, groups 2 and 4 have a higher average of total resident population, as well as higher population density, higher average basic remuneration by worker and higher percentage of resident population with more education. It is notorious that these are the groups with more “++” signs. On the other hand, these groups oppose the first and fifth ones, which have lower levels of total resident population, lower population density, lower average basic remuneration by worker and higher percentage of population without education. Groups 1 and 5 are also the ones with lower percentage of resident people less than 25 years old but higher percentage of residents more than 64 years old. This division is not straightforward regarding the variables related to the number of pharmacies per resident, the percentage of resident people benefiting from the guaranteed minimum income and the ones enrolled in the Employment and Professional Training Institutes, that works as a proxy for the unemployment rate. Nonetheless, the groups can be ordered by a decreasing level of various socioeconomic

Figure 2: Groups of counties



Notes: This Figure shows the geographical localization of the counties belonging to each group that resulted from the cluster analysis.

indicators as follows: $2 > 4 > 3 > 1 > 5$.

Although medicines for the cardiovascular system, nervous system and alimentary tract are the ones more bought (see the correspondence between the first level of the ATC code and the organ or system of organs over which the medicines act in the Appendix), there are yet some differences across municipalities (see Figure 3). Lisbon, Sintra and Vila Nova de Gaia, for instance, are the ones where less units of medicines that act in the cardiovascular system (code C) are bought but are where more drugs for the respiratory system (code R) are bought, opposed to the counties in the interior. Therefore, some medicines sell more in different regions, probably due to the health problems that may vary between counties. The coast counties suffer more from air pollution and indeed seem to be the ones that need more medicines for respiratory diseases.

As it can be seen in part a) of Table 4, the shares of medicines in their respective homogeneous group are higher for group 2, meaning that this is the group that diversifies less between the available equivalent drugs, as well as the group number 4. On the other hand, the counties from group 5 are the ones that have lower market shares of each equivalent drug, which indicates that more equivalent drugs are bought at the same time.

We can also have an idea of the differences between regions related to the preferences for generic or branded products. In panel b) of Table 4, the average of the shares of all the equivalent generic products for each group of counties is represented. Notice that these shares

Table 3: Characterization of the counties' groups

Socioeconomic variables	Groups				
	1 (Big cities from the interior)	2 (Lisbon, Sintra and Vila Nova de Gaia)	3 (Coast counties and district capitals)	4 (Metropolitan areas of Lisbon and Oporto)	5 (Counties from the interior)
<i>youngpeople</i>	-		++	+	--
<i>oldpeople</i>	+		--	-	++
<i>totalpop</i>	-	++		+	--
<i>pharmpc</i>	+		-	--	++
<i>minincome</i>	--	++		-	+
<i>unemp</i>	--	++		+	-
<i>density</i>	-	++		+	--
<i>income</i>	-	++		+	--
<i>noeduc</i>	+	--		-	++
<i>highsch</i>	-	++		+	--
<i>acdegree</i>	-	++		+	--

Notes: This Table represents the relative characterization of the groups of counties. The sign “- -” indicates the group of counties with the lowest average value of the respective variable, opposed to the sign “+ +” that indicates the group of municipalities with the highest average value. The vertical bar indicates the intermediate one. In order to create the groups, it was considered annual data on every mentioned variable for each of the 308 Portuguese municipalities between 2013 and 2018, with the exception of the variables *noeduc*, *highsch*, and *acdegree* that were assumed constant over time for each county.

were computed in each homogeneous group and in the table we have only an aggregated mean of all the homogeneous groups, not controlling for the possibility of some counties buying more of one specific type of medicines that can even have more equivalent generic drugs available to choose while others buy more of another type of drugs without many generic substitutes available. However, it is possible to have an idea that the municipalities belonging to group 5 (the group with the lower socioeconomic conditions and less education) are the ones that buy a higher percentage of generic drugs, opposed to the more developed counties. Moreover, it is even possible to see that the generic shares are slightly increasing during the period in analysis, as expected.

Figure 3: Types of drugs bought by groups of counties

ATC (first level)	Groups				
	1	2	3	4	5
A - Alimentary tract and metabolism	14,72%	14,78%	14,59%	14,68%	15,54%
B - Blood and blood forming organs	1,57%	1,18%	1,38%	1,17%	1,72%
C - Cardiovascular system	32,48%	29,67%	31,89%	31,24%	34,14%
D - Dermatologicals	0,43%	0,51%	0,44%	0,45%	0,39%
G - Genito-urinary system and sex hormones	4,46%	4,71%	4,53%	4,62%	3,96%
H - Systemic hormonal preparations, excluding sex hormones and insulins	2,33%	2,43%	2,39%	2,36%	2,17%
J - Antiinfectives for systemic use	3,31%	3,68%	3,63%	3,66%	2,68%
L - Antineoplastic and immunomodulating agents	0,24%	0,35%	0,26%	0,33%	0,21%
M - Musculo-skeletal system	7,73%	7,12%	7,22%	6,91%	7,69%
N - Nervous system	25,84%	25,70%	26,47%	26,32%	26,17%
R - Respiratory system	6,81%	9,78%	7,13%	8,17%	5,26%
S - Sensory organs	0,07%	0,09%	0,07%	0,08%	0,07%
Total	100,00%	100,00%	100,00%	100,00%	100,00%

Notes: The Figure reports the shares of medicines sold (in units) included in each ATC code, only until the first level. Notice that it identifies the anatomical main group of the medicines, i.e. the system or group of organs over which the medicine acts.

Table 4: Shares of individual drugs and generic drugs as a whole

a) Average shares of individual medicines (in their homogeneous group)

Year	Groups of counties					Average
	1	2	3	4	5	
2013	10.61%	11.50%	10.91%	11.22%	10.09%	10.86%
2014	9.86%	10.56%	10.11%	10.36%	9.38%	10.05%
2015	9.74%	10.36%	9.93%	10.17%	9.25%	9.89%
2016	9.67%	10.25%	9.89%	10.10%	9.19%	9.82%
2017	9.62%	10.16%	9.83%	10.02%	9.13%	9.75%
Average	9.89%	10.55%	10.12%	10.36%	9.40%	

b) Average shares of generic drugs (in their homogeneous group)

Year	Groups of counties					Average
	1	2	3	4	5	
2013	53.67%	57.49%	55.58%	57.38%	52.47%	55.32%
2014	55.79%	58.95%	57.36%	59.25%	54.67%	57.20%
2015	56.84%	59.67%	58.19%	59.48%	55.81%	58.00%
2016	57.09%	59.38%	58.25%	59.45%	56.36%	58.10%
2017	57.66%	59.54%	58.73%	59.65%	57.09%	58.53%
Average	56.21%	59.01%	57.62%	59.04%	55.28%	

Notes: Panel a) reports the average share, in units, of the individual medicines sold in each group of counties over the period in analysis. These shares are calculated with respect of the homogeneous group in which the medicines are inserted. Panel b) shows the average share of all the equivalent generic drugs, in units, also computed for each homogeneous group.

4 Econometric analysis

4.1 Changes in individual drug market shares when new equivalent medicines are introduced

In order to try to understand the changes in the share of each individual drug when a new equivalent generic is introduced in the market, a regression was run. It takes the variable *drugshare* as its dependent variable, representing the share of each medicine in the total sales of its respective homogeneous group, in units, in the considered county and year. Assuming that the shares may vary depending on the fact that the product is a generic or not, the variable *generic* is included, which is a dummy variable that takes the value 1 if the observed drug is a generic product and 0 otherwise. It was also expected that the medicines with higher prices paid by consumers have lower shares when compared to the other equivalent drugs, and so the unitary out-of-pocket price was computed and introduced in the regression with the logarithm ($\log(\text{outpocketuni})$).¹ Because we are only interested in comparing the shares of the equivalent drugs sold, i.e. the drugs that belong to the same homogeneous group, the unitary out-of-pocket price was computed as the difference in the price of that specific drug and the price of the equivalent drug with the lowest price in the respective homogeneous group, as previously mentioned, per unit. Moreover, due to the aggregation of the data in counties, it was not possible to distinguish which and how many drug sales were covered by the general or the special reimbursement regimes. However, since the majority of the sales are covered by the general regime (see Table 9 in the Appendix), the analysis was made assuming this regime for all the sales.² So as to allow for some differences in the drug shares between the different regions that are characterized by their socioeconomic variables, these were also included: *youngpeople*, *oldpeople*, *pharmpc*, *minincome*, *unemp*, *density*, *income*, *noeduc*, *highsch* and *acdegree*. Additionally, in order to study the impact of the introduction of new equivalent drugs in the market, two new crucial variables were created as well: the variable *newgen* identifies the number of new generic drugs in that homogeneous group for that year, and *newbrand* identifies the number of new branded products that entered in that homogeneous group in that period. So as to allow different effects on the market share of generic versus branded drugs sold inside their respective homogeneous group and county, these last two variables were also crossed with the dummy variable *generic*. Therefore, the first estimated regression is the following:

¹The variable *outpocketuni* is introduced in the regression with the logarithm in order to simplify the interpretation of its coefficient. In this way, the obtained coefficient is a semi-elasticity. Therefore, the interpretation should be that an increase in the price paid by patients of 1% will lead to an increase (or decrease, in the case of a negative sign) of the drug share of X/100 units. Since we are considering the share, which is a number between 0 and 1 (or a percentage) its unit is the percentage point (p.p.).

²The same analysis assuming the special reimbursement regime will be done in Section 5.

$$drugshare_{m,c,t} = \beta_0 + \beta_1 generic_m + \beta_2 \log(out\ pocketuni)_{m,c,t} + \beta_3 newgen_{g,t} + \beta_4 newbrand_{g,t} + \beta_5 newgen_{g,t} \times generic_m + \beta_6 newbrand_{g,t} \times generic_m + \beta \mathbf{X}_{c,t} + \alpha \mathbf{Z}_c + \varepsilon_{m,c,t} \quad (1)$$

where the vector \mathbf{X} represents all the socioeconomic variables that change across time and \mathbf{Z} represents the variables related to education (remember that they were assumed as constant). Regarding the components, m identifies each medicine, g identifies the homogeneous group, t relates to the year and c identifies the county. Remark that the variables *drugshare*, *generic* and *outpocketuni* do not have the component g that identifies the homogeneous group, since one specific drug can only be part of one group. Therefore, each medicine m is immediately identified by the matching homogeneous group.

Notice that a positive coefficient indicates that the variable contributes to a higher share of each medicine m sold in the total sales of its respective homogeneous group g , in units, in the considered county c and period t . On one hand, if the obtained coefficient β_1 is positive (the one associated with the dummy variable *generic*), it means that the share of each individual generic drug is greater than the one for a branded-name product, on average, considering everything else constant. Similarly, if a positive β_2 is obtained, it means that the higher the unitary out-of-pocket price, the higher the expected share of the individual medicine, on average, *ceteris paribus*. Regarding the coefficient on the *generic* variable, no information is known until now that allows to predict its sign but, as previously mentioned, it is expected that a higher price leads to a lower drug share, since people usually respond to higher prices with lower quantities demanded, thus it is expected a negative coefficient associated with the variable $\log(out\ pocketuni)$. Additionally, the coefficient on *newgen*, β_3 , is expected to be negative, indicating that the shares of the branded products sold tend to reduce when new equivalent generic drugs are introduced. Similarly, the sum of β_3 and β_5 is also expected to be negative, with the value of β_5 reinforcing the effect of β_3 , since one more equivalent generic drug in the market is expected to reduce the individual shares of the other generic drugs already existent, even more than the reduction in the individual shares of the brand medicines. Likewise, the coefficients β_4 and β_6 , associated with the effects of the introduction of new equivalent brand medicines, are expected to be negative too. However, it is worth mentioning that it is not very common for new equivalent brand drugs to appear in the market after the patent expiration of other brand products already established in the market and, consequently, the coefficients may not be statistically significant.

Finally, regarding the socioeconomic variables included, a positive coefficient will also represent that the higher the value of each variable, the higher will be the individual share of each drug, in the correspondent homogeneous group, county and year. In that way, a positive coefficient associated with the variable *unemp*, for instance, means that people from a county characterized by a higher proportion of adult people enrolled in Employment and Professional Training Institute, i.e. with more unemployment, tend to diversify less the medicines bought

when compared to resident people in a county with lower unemployment, since higher drug shares is only possible to obtain when less medicines are sold. Thus, the coefficients associated with each of the socioeconomic variables will allow us to identify if those characteristics can be associated with a higher or lower degree of diversity.

It is expected that the counties with a higher percentage of young people are more available to diversify, opposed to those with a higher percentage of old people. Similarly, the higher the number of pharmacies per resident as well as the higher the population density, the higher the diversity is expected to be, resulting in lower shares. Additionally, it is expected that people that benefit from the guaranteed minimum income or unemployed are more available to try different medicines and thus diversify more, opposed to the ones with higher income, thus leading to negative coefficients associated with variables *minincome* and *unemp* but a positive one associated with *income*. People with higher education are usually more informed about the equivalence of generic drugs and so the coefficients associated with *highsch* and *acdegree* are expected to be negative, indicating that the drugs shares are low for counties with higher levels of education, contrasting to the coefficient on *noeduc* that is expected to be positive for the opposed reason.

The coefficients obtained are shown in the first columns of Table 5.

Table 5: Outputs from equations (1) and (2)

Dependent variable: <i>drugshare</i>	(1)		(2)	
	coefficient	<i>p</i> -value	coefficient	<i>p</i> -value
<i>generic</i>	−.2265	0.000	−0.2552	0.000
$\log(\text{out pocketuni})$	−0.0086	0.000	−0.0086	0.000
<i>newgen</i>	−0.0016	0.000	−0.0029	0.000
<i>newbrand</i>	−0.1707	0.000	−0.1800	0.000
<i>newgen</i> × <i>generic</i>	−0.0033	0.000	−0.0014	0.000
<i>newbrand</i> × <i>generic</i>	0.1825	0.000	0.1933	0.000
<i>youngpeople</i>	0.0259	0.000	0.0383	0.000
<i>oldpeople</i>	−0.0002	0.952	0.0031	0.425
<i>pharmpc</i>	−2.5887	0.000	−2.4961	0.000
<i>minincome</i>	−0.0448	0.000	−0.0498	0.000
<i>unemp</i>	0.0463	0.000	0.0555	0.000
<i>density</i>	$5.24e^{-7}$	0.000	$4.84e^{-7}$	0.000
<i>income</i>	$-3.22e^{-6}$	0.000	$-4.11e^{-6}$	0.000
<i>noeduc</i>	−0.0109	0.001	−0.0095	0.003
<i>highsch</i>	0.0010	0.779	−0.0003	0.941
<i>acdegree</i>	0.0372	0.000	0.0401	0.000
<i>relativeage</i>			−0.0072	0.000
<i>relativeage</i> × <i>generic</i>			0.0094	0.000
<i>constant</i>	0.2403	0.000	0.2581	0.000
Number of observations	9,620,593		9,620,593	
R-squared	0.1709		0.1714	

Notes: The Table shows the obtained coefficients and *p*-values for regressions (1) and (2), run using the OLS estimators and assuming the general reimbursement regimes for all the sales.

The shares of generic products are smaller by, on average, 0.2265 p.p than the shares of the equivalent branded medicines, as shown by the coefficient associated with the dummy variable *generic* (β_1). This may happen due to two main reasons: there are more generic drugs in each homogeneous group, on average, and so the individual share of each one is smaller, but it is also possible that people buy more branded products in total. In fact, the average number of generic drugs in each homogeneous group is 8.7, whereas the average number of brand-name drugs is 1.7. Nevertheless, the last hypothesis is not supported by the descriptive statistics presented before (see panel b) of Table 4 in the previous section), so it was concluded that, the lower shares of the generic drugs has to do with the higher availability of generic equivalent products. Also, as expected, as the out-of-pocket price increases by 1%, it is estimated that the share of the product decreases by 0.000086 p.p., on average. Thus, the higher the price, the lower the share of the product, but by a small amount.

The diversification between equivalent medicines may arise in part from the consumers' habits but also from the availability of different drugs in each region. Despite the pharmacies having to provide access to at least three of the five equivalent generic drugs, if there are more pharmacies in a county there may also be available different generics, since each pharmacy could provide different equivalent generic products, from different producers. Actually, the coefficient on the variable *pharmpc* is negative, meaning that the more pharmacies per resident tend to lead to lower shares of each drug, which supports this idea.

Notice, however, that the counties with a higher percentage of people benefiting from the guaranteed minimum income have lower shares of each individual medicine, considering everything else constant, since the coefficient on *minincome* is negative, which means that people tend to diversify more between the equivalent drugs. What is unexpected is the fact that the coefficient on *income* is also negative, meaning that the counties with people receiving a higher income also tend to diversify, not being loyal to one specific brand. Regarding the education level, it is interesting to see that people with an academic degree seem to be more loyal to the same drugs, not allowing for a great diversity, since the shares tend to be lower when compared to people without any education: note that the coefficient on *acdegree* is positive, whereas the one associated with *noeduc* is negative meaning that people with no education tend to buy less units of the same equivalent medicine, opposed to the expected results. It was also estimated that, *ceteris paribus*, the counties in which there is a higher percentage of young people, a higher percentage of unemployed people or even the ones with a higher population density are the ones in which the individual drug shares are higher, meaning that these tend to be loyal to the same medicines, without diversifying contrarily to the expected hypothesis.

Besides these regional preferences, let us then focus on what happens to the shares when new equivalent drugs are introduced in the market: it is estimated that when a new equivalent generic medicine is introduced, the share of all the other (equivalent) drugs decreases, with the share of the generic drugs decreasing more 0.0033 p.p. than the shares of branded drugs (see coefficients β_3 and β_5 in the second column of Table 5). On the other hand, in the case of

an introduction of a new equivalent branded product (like the situation in which another brand produces an identical product to one already in the market), the shares of the branded medicines are expected to decrease even more than when it was a new generic drug entering the market (they are expected to decrease by 0.1707 p.p. when a new branded product enters the market, but decrease only 0.0016 p.p. when the entering product is a generic one). Notwithstanding, a new branded drug is expected to increase the shares of the generic products by, on average, 0.0117! This is an unpredicted but curious result! However, it is worth mentioning that the introduction of a non-generic product in an already existent homogeneous group is not very common since, usually, the branded products are the first ones to be developed and commercialized and only after the patent expiration new equivalent generic products appear in the market, thus leading to the creation of the homogeneous group.

The R-squared of this regression is not really high, but it must be considered that there are many other variables that certainly explain the shares of medicines and are not considered in the equation. Examples of these possible features are hereditary factors that may contribute to a necessity to certain medicines, consumers aversion to generic drugs or even previous allergic reactions of some active substances included in drugs. These are factors that can only be exploited if individual data is available, which is not the case in this study, but they were assumed as uncorrelated with the main variables included in the regression. This might be an unrealistic assumption, but it is what was possible with the available data. Notice, however, that these aspects not covered in the regression will be included in the error term, $\varepsilon_{m,c,t}$. Note also that only two socioeconomic variables seem to be non-statistically significant: *oldpeople* and *highsch*, which means that they do not seem to explain the dependent variable *drugshare*.

4.2 The market share of each individual drug as time passes by

The literature has already shown that there is a certain aversion to the consumption of generic products in detriment of branded drugs. However, many governments are trying to solve this problem by applying some new policies and even advertisement campaigns that may lead to a lower aversion from consumers. Specifically in Portugal, some measures have been taken, such as the previously mentioned requirement that the medical prescriptions must be done using the NII instead of the brand of the medicine, which can be considered as part of a nudge technique that tries to influence consumers' behavior without forbidding brand drugs, or the requirement that pharmacies have available at least three of the five generic products with the lowest prices of their respective homogeneous group, as an attempt to guarantee that generic products are available. Additionally, the INFARMED has been practicing some marketing and information campaigns in order to contribute to a well-informed society. But are these measures having a positive effect? In order to test if the measures that promote generic drugs have been effective, one more variable was created and included in the previous model: *relativeage*. This variable identifies the age of the medicine starting at 2012, i.e. it takes the value 1 in the first period of

the sample with positive sales and after that it sums one as one more year passes by. This is just a simple way of controlling for what happen as time passes, from the moment when the drug first appears in the database onwards. So as to allow different effects on the share of generic versus branded drugs, it was also crossed with the dummy variable *generic* and, if policies are having positive effects, it is expected a negative sign on β_7 but a positive and greater one on β_8 . Therefore, the estimated regression now is the following:

$$\begin{aligned} drugshare_{m,c,t} = & \beta_0 + \beta_1 generic_m + \beta_2 \log(out\ pocketuni)_{m,c,t} + \beta_3 newgen_{g,t} + \beta_4 newbrand_{g,t} + \\ & + \beta_5 newgen_{g,t} \times generic_m + \beta_6 newbrand_{g,t} \times generic_m + \\ & + \beta_7 relativeage_{m,t} + \beta_8 relativeage_{m,t} \times generic_m + \beta \mathbf{X}_{c,t} + \alpha \mathbf{Z}_c + \varepsilon_{m,c,t} \quad (2) \end{aligned}$$

As previously mentioned, the vector \mathbf{X} represents all the socioeconomic variables that change across time, and \mathbf{Z} represents the variables related to education (they were assumed as constant over time). The components are also the same as in the previous regression.

The R-squared increased slightly, but the difference is not that significant. Nonetheless, the coefficients obtained (see Table 5) are very similar to the previous regression without the two new variables. Hence, one can easily see that, everything else constant, the shares of the generic and non-generic drugs tend to change in different directions: branded products tend to have lower shares over the years, while the generic products tend to see their shares increase over time. Moreover, we estimate that one more year makes generic shares increase by 0.0022 p.p., on average, while the branded product shares tend to decrease by 0.0072 p.p. as one more year passes by, on average. Thus, the decrease of the non-generic product shares is higher in absolute value than the increase in the generic drug shares.

Therefore, one can conclude that the policies and measures that have been implemented seem to be effective, since the predictions about the coefficient signs were verified. Thus, as time passes by it can be observed an increase on generic drugs shares and a decrease on the shares of non-generic products, *ceteris paribus*.

4.3 The market shares of all the equivalent generic drugs

The previous regressions allow us to understand what happens to the consumption of each individual drug, being it a generic product or not, when there are some changes in selected socioeconomic variables, the drug's prices and even some changes in the composition of the homogeneous group. It also allows us to identify some consumer's preferences over the same medicines or their availability to diversify. However, if we are talking about equivalent drugs and the focus is the share of generic products as a whole, we should actually try to understand what happens to their aggregated shares in the respective homogeneous group. It was seen that generic drugs tend to have lower shares than the non-generic ones, but is it true that the share of all the equivalent generic drugs is smaller than the share of the branded products? In order

to answer this question, no econometric regression is needed. Computing the average of the generics' share in each homogeneous group we get a value of 56,2%, which means that for the competitive drug market where substitutes are available, the generic drugs have a higher share than the branded ones. But how does it change when new medicines are introduced in the homogeneous group? A new econometric regression was estimated in order to answer this question that also helps us to understand consumer's preferences over generic drugs:

$$genericshare_{g,c,t} = \beta_0 + \beta_1 genericprop_{g,t} + \beta_2 newgen_{g,t} + \sum_{k=3}^{13} \beta_k D_{k,g} + \beta \mathbf{X}_{c,t} + \alpha \mathbf{Z}_c + \varepsilon_{g,c,t} \quad (3)$$

Similarly to the previous equations, the vector \mathbf{X} represents all the socioeconomic variables that change across time, and \mathbf{Z} represents the variables related to education (assumed as constant over time). Once again, the components are the same.

The dependent variable is now the share of all the generic drugs in their respective homogeneous group g , in period t and for the county c . The regressors included are the previous socioeconomic variables, the number of new generic drugs introduced in the homogeneous group g in period t (*newgen*), a new variable named *genericprop* that represents the proportion of the generic products that exist in the homogeneous group g at time t , and some dummy variables that identify the ATC code (until the first level) of the observed homogeneous group g . This said, we are now looking just at the homogeneous group level, and not taking into consideration the individual medicines that belong to it, so it is as if we have now a more general overview of the market.

Notice that a positive coefficient associated with the *genericprop* is expected, since more equivalent generic drugs available should also lead to a higher percentage of generic drugs sold, as a whole. However, the coefficient on the variable *newgen* must be interpreted very carefully: in order for us to interpret it directly, using a *ceteris paribus* analysis, we should consider that the proportion of generic drugs in the respective homogeneous group should remain unchanged, since the variable *genericprop* is also included in the regression. Therefore, a positive coefficient on the variable *newgen* means that adding one more generic drug in one homogeneous group while adding the correspondent proportion of branded medicines such that the proportion of generic ones does not change, the total share of generic drugs sold will increase, and so the generic drugs will capture a higher proportion of the market.

Additionally, positive coefficients associated with a socioeconomic variable will now mean that the higher its value is, the higher the consumption of generic drugs will be. For instance, a positive coefficient associated with the variable *unemp* means that, *ceteris paribus*, the counties with higher levels of unemployment seem to be the ones with a higher preference for generic drugs. Thus, it is expected a positive coefficient associated with the variable *young-people*, opposing the one associated with *oldpeople*, since the elder tend to be more reluctant to changes of habits. The counties with a higher number of pharmacies per resident are also ex-

pected to have a higher share of all the equivalent generic drugs since more equivalent generic drugs will be available and so it is expected a positive coefficient on *pharmpc*. Since people with high education levels are usually more informed, the coefficients on *highsch* and *acdegree* are expected to be positive too. Contrarily to these, the coefficient on *noeduc* is expected to be negative for the opposite reason, as well as the one associated with the variable *income*, due to the fact that people with high income may prefer to continue using the same brand-name products and be more reluctant to change. Counties with a higher percentage of unemployed people and higher percentage of people benefiting from the guaranteed minimum income are expected to buy more generics and so the coefficients associated with *unemp* and *minincome* will be positive. Similarly, due to the easier spread of information where the population density is higher, it is expected a positive coefficient on *density*, too. Finally, the dummy variables that identify the first level of the ATC code will allow us to see if there are some significant differences in the consumers' preferences for generic drugs depending on the organ or system of organs over which the medicines act.

The obtained coefficients are shown in the first columns of Table 6.

Regarding the socioeconomic factors considered, it is interesting to see that the higher the average income in the municipality, the lower the generic share, probably indicating that people with a higher income are more willing to pay a higher price and buy the branded product. On the other hand, the higher the percentage of unemployment in the county, the higher the generic consumption as well, but the more percentage of people that benefit from the guaranteed minimum income, the lower the generic shares, which is an unexpected result since it seems to go against the obtained coefficient on the *income*.

It was also expected the people with higher levels of education, who are well-informed about the equivalence and availability of the generic products, would be the ones that could buy more generics. However, the coefficient on *acdegree* is negative, which supports the opposite and contradicts the previous literature (see Dylst et al., 2013; Quintal and Mendes, 2012 and Vallès et al., 2003). This seems to be a situation in which the correlation between income and level of education is very high (note that the correlation between these two variables – *income* and *acdegree* – is about 0.66), leading to unexpected results, as previously argued. Furthermore, there seems not to be significant differences in the preferences for generic drugs between people of different ages, with the coefficients associated with the percentage of young and old people being both negatives. The coefficient on *density* confirms that the counties with higher population density have higher preferences for generic drugs as expected, since a positive coefficient was obtained, but it was curious to find a negative coefficient associated with the variable *pharmpc*, which contradicts the prediction that more pharmacies would lead to higher shares of the generic drugs in total.

Particularly interesting are the results obtained for the variables related to the composition of the homogeneous group. The coefficient on *genericprop* indicates that as the percentage of generic drugs existent in the homogeneous group increases by 1 p.p., the generics share is esti-

Table 6: Outputs from equations (3) and (4)

Dependent variable: genericshare	(3)		(4)	
	coefficient	p-value	coefficient	p-value
<i>genericprop</i>	0.9255	0.000	0.9125	0.000
<i>newgen</i>	-0.0358	0.000	-0.0355	0.000
<i>youngpeople</i>	-0.1341	0.000	-0.2072	0.000
<i>oldpeople</i>	-0.0993	0.000	-0.1320	0.000
<i>pharmpc</i>	-7.5622	0.000	-6.2637	0.005
<i>minincome</i>	-0.1617	0.000	-0.1521	0.000
<i>unemp</i>	0.2993	0.000	0.3283	0.000
<i>density</i>	$3.65e^{-6}$	0.000	$4.25e^{-6}$	0.000
<i>income</i>	$-1.22e^{-5}$	0.000	$-1.31e^{-5}$	0.004
<i>noeduc</i>	-0.0155	0.268	-0.0047	0.786
<i>highsch</i>	0.0138	0.387	0.0192	0.335
<i>acdegree</i>	-0.0557	0.000	-0.1177	0.000
<i>A</i>	0.0256	0.000	0.0257	0.000
<i>B</i>	0.0253	0.000	0.0466	0.000
<i>D</i>	0.0053	0.026	-0.0799	0.000
<i>G</i>	-0.0784	0.000	-0.1578	0.000
<i>H</i>	-0.0697	0.000	-0.1713	0.000
<i>J</i>	-0.0313	0.000	-0.0372	0.000
<i>L</i>	0.1231	0.000	0.1452	0.000
<i>M</i>	-0.0044	0.000	-0.0238	0.000
<i>N</i>	0.0059	0.000	-0.0072	0.000
<i>R</i>	-0.1116	0.000	-0.1712	0.000
<i>S</i>	-0.2791	0.000	-0.5804	0.000
<i>pricedif</i>			0.0217	0.000
<i>constant</i>	-0.0066	0.471	0.0070	0.540
Number of observations	933,919		717,032	
R-squared	0.5350		0.3362	

Notes: This Table shows the results obtained with regressions (3) and (4), using the OLS estimators. For the calculation of the variable *pricedif* in regression (4), it was assumed that all medicines were covered by the general reimbursement regime. The dummy variables A to S represent the first level of the ATC code, with category C being the base level. See Table 7 in the Appendix for the correspondence between the ATC code and the group of organs that they represent. The number of observations in equation (4) is smaller than in the previous regression because for some homogeneous groups only generic products or only branded drugs were sold. As a consequence, it is not possible to compute the variable *pricedif* for those observations and they were excluded.

mated to increase by, on average, 0.9255 p.p., as it was expected, supporting the hypothesis that the more generic products available, the higher the generics share. However, as previously mentioned, one should interpret the coefficient on *newgen* very carefully. This coefficient is negative (-0.0358) which means that, *ceteris paribus*, one more generic drug leads to a decrease in the generics share. Nevertheless, note that it is true only if we consider that all the other variables remain constant. Thus, in order for the proportion of the generics in the homogeneous group to remain constant when one more generic product is introduced, we need to be introducing the same proportion of branded products. Consequently, that coefficient indicates that as we introduce one more generic drug in the homogeneous group while introducing at the same time the equivalent proportion of non-generic products, the share of all generic products is expected to decrease by, on average, 0.0358 p.p.. As previously mentioned, it is not very common that new branded products enter the market in a homogeneous group that already exists. However, this regression allows us to see that if we introduce the same proportion of generic and branded products, the last ones will immediately capture a higher share of the market.

The dummy variables that allow to identify the organ or system of the human body over which the medicines react allow us to identify that there are in fact some differences in the utilization of generic groups depending on the type of medicine. The group used as the reference group is the ATC C, that includes the medicines that act in the cardiovascular system, since it is the group that represents the highest portion of all the medicines sold in Portugal, in units, as seen in Figure 3. Therefore, the coefficients on each dummy variable supports the hypothesis that the generic consumption is higher when we consider some ATC groups, such as group L, A and B, that include antineoplastic and immunomodulating agents, medicines for the alimentary tract and metabolism and for the blood and blood forming organs, respectively. On the other hand, the medicines included in groups S and R are the ones with a lower share of generics, which include medicines for the sensory organs and respiratory system, respectively. Crossing these coefficients with the descriptive statistics table presented before (see Figure 3 again), it is also possible to conclude that the medicines that have less sales are not necessarily the ones with the lowest generic sales, since the ones belonging to group L (antineoplastic and immunomodulating agents) are some with the highest share in terms of generic products but they are also the second group with lower sales in total. On the opposite side, the drugs included in group R, for instance, form the fourth group with more sales in the market, but this is one of the groups with lower share of generic products sold.

4.4 Including price differences

With the previous regression it was possible to have a wider perspective of the generics share inside each homogeneous group. However, the difference in the price paid by consumers when buying a generic or a non-generic drug is not being taken into consideration, but it may differ from one homogeneous group to others. Furthermore, previous researchers considered the price

difference in their studies and found that it is a significant variable, with larger differences in price of both types of drugs leading to a higher consumption of generic medicines (see Aronsson et al., 2001 and Carrera and Villas-Boas, 2015). In order to control for the cases where the difference between buying a branded product is much more expensive than buying a generic one, a new variable should be introduced. The point is that, since we are aggregating all the generic and non-generic products of the respective homogeneous group, the only price we can consider is the average price of each kind of medicines (generics or non-generics). Hence, the variable named *pricedif* was computed and introduced in the regression, which corresponds to the difference of the average price of the generic products and the average price of the branded products for the respective homogeneous group, and a positive coefficient is expected in order to go along with the literature previously mentioned. Notice that, as in regressions (1) and (2), the prices considered are only the part actually paid by consumers. Moreover, due to the data aggregation, it was assumed here that all the sales were made under the general reimbursement regime as well.³

Hence, the estimated equation is now:

$$\begin{aligned} genericshare_{g,c,t} = & \beta_0 + \beta_1 pricedif_{g,t} + \beta_2 genericprop_{g,t} + \beta_3 newgen_{g,t} + \\ & + \sum_{k=4}^{14} \beta_k D_{k,g} + \beta \mathbf{X}_{c,t} + \alpha \mathbf{Z}_c + \varepsilon_{g,c,t} \end{aligned} \quad (4)$$

where the vector \mathbf{X} represents all the socioeconomic variables that change across time, and \mathbf{Z} represents the variables related to education (assumed as constant over time). Components remain the same as before.

The obtained results are expressed in the last two columns of Table 6. Notice, however, that now the number of observations is smaller than in the previous regression without this variable included, as well as the R-squared. Nevertheless, notice that the excluded homogeneous groups should actually be in the regression but with the values for *genericshare* being equal to 1 or 0, depending on the situation of only generic medicines or only branded products having been sold, and that is the reason why they were not excluded when equation (3) was run.

The coefficients found were similar to the ones obtained in the previous regression, but now we can confirm that the difference in the prices of generic and non-generic drugs is statistically significant, and the higher this difference is, the higher the generics share will be. It goes along with the expected result (see Aronsson et al., 2001 and Carrera and Villas-Boas, 2015).

³See the following section for an equivalent analysis that considers all the sales covered by the special reimbursement regime.

5 Assuming the special reimbursement regime for all drug sales

As it was already mentioned, due to the aggregation of data it was not possible to identify which and how many drug sales were covered by the general and the special reimbursement regimes. All the previous analyses were made assuming that every sale was covered by the general regime, since it was the one applied in more than 60% of the total sales of medicines in Portugal (see Table 9 in the Appendix). However, the special regime is applied to medicines used in diseases specified in government ordinances, but also when patients have a low income. Since this last aspect may interfere specifically with some socioeconomic factors considered in the analysis previously presented, regressions (1), (2) and (4) were run once again but now considering that all sales were made under the special reimbursement regime. This difference has only an impact in the variables *outpocketuni* and *pricedif*, since the percentage applied to the reference price of each medicine is now higher. Therefore, since equation (3) does not take prices into consideration, it has no impact at all and is not considered in this section.

See Table 10 in the Appendix for the results obtained by running regressions (1) and (2).

The coefficients obtained for equation (1) are very similar to the ones obtained previously. However, the variable *oldpeople* is now statistically significant, meaning that it seems to explain the individual market shares of the medicines sold. Nevertheless, its associated coefficient has a negative sign, just like the one associated with the variable *youngpeople*. Consequently, it seems that aging does not change that much consumers' preferences for diversify. Under this regime, the variable *highsch* seems to be non-statistically significant as previously, but *income* does not seem to explain the dependent variable. Note that the coefficients associated with the crucial variables that account for the entrance of new medicines in the homogeneous group continue to show similar results as previously, so no significant differences are found due to the changes in the considered reimbursement regime.

Similarly, the results obtained from regression (2) are even more similar to the ones obtained previously (see Section 4.2). The only difference is that now the cross variables *newgen* \times *generic* seem to be non-statistically significant, which means that there is no significant difference in the effect of the introduction of one more generic drug in the shares of generic versus brand-name medicines: the shares of both kinds of medicines are expected to decrease by, on average, 0.0036 p.p., *ceteris paribus*.

At last, Table 11 in the Appendix shows the results obtained with regression (4). Actually, the coefficients obtained have not only the same sign but are also very close in value to the ones obtained when the general regime was assumed. Hence, the analysis presented before seems to be valid.

However, it is worth mentioning that the R-squared values of these regressions assuming the special regime are slightly lower than the ones obtained previously.

6 Robustness

All the econometric regressions presented above were performed using the Ordinary Least Squares (OLS) method. Actually, it is one of the most standard estimation methods used worldwide in a great variety of studies and different situations. The reason why it was used also here in this analysis was due to its great generality and adaptability, but one may argue that this is not perfectly appropriate for the analyzed data.

In fact, both equations (1) and (2) have the variable *drugshare* as the dependent variable, which has a very big quantity of null observations. Actually, its mean is 0.0558 and up to percentile 50 it only takes the value zero. In the same way, the equations (3) and (4) that includes *genericshare* as their dependent variable also have a similar problem, but in that case with a great number of observations taking the value zero and one.

Because of that, a censored or truncated model that takes into account the great number of zero values such as the Tobit model was also taken into consideration when choosing the best model. However, these null values in the data are not censored in any sense, since they are equal to 0 only because the medicine *m* was actually not sold in that county *c* and period *t*. Therefore, it is not the case of censoring the data in order to transform into zero all the values below that or other similar censoring mechanism. The data is what it is, and nothing is being changed. For that reason, it was concluded that the Tobit model is not really appropriate for this database. Nevertheless, the analysis was also made using the Tobit model. The obtained results can be found in the Appendix (Tables 12 and 13), but they are very similar to the ones obtained with the OLS model and presented above. The only differences found are related to the variables *newbrand* in equations (1) and (2): when a new branded product is introduced, according to the Tobit estimations, it is expected that the share of generic drugs decreases. Notice that the OLS model concluded the opposite, but it must be taken into consideration that it is very uncommon to have new branded drugs entering the market as substitutes of another brand-name medicine already established. Therefore, this result does not seem very relevant.

In addition to the previous approach, the zero inflated negative binomial method was also considered. This model also allows for a great number of zero values in the observations, but in fact it should be used with count data. Notice, however, that both dependent variables considered are market shares, computed taking into account the units purchased, and therefore they are not count data. Therefore, it does not make sense to apply this estimation data in our analysis.

Consequently, the OLS method seems the best model to fit the data.

7 Conclusion

The main purpose of this dissertation is to understand the consumers' preferences over generic drugs by looking at the revealed choices of those products by individuals through sales and

how the demand of those goods relatively to the brand ones are affected when new generic drugs are introduced in the market. It is expected that those consumer's preferences depend on socioeconomic conditions or at least that the decisions to buy a given type of medicine derive from given preferences and interact with the consumer's economic conditions. Because of that, it is checked how several socioeconomic indicators can explain either the relative demand of new generics as well as the evolution of that demand with time.

The main results indicate that, depending on these socioeconomic factors, some counties tend to diverse more than others the various medicines purchased, i.e. the market shares of each individual drug are lower in some regions than in others. Moreover, if one new generic drug is introduced in the market, a decrease can be seen in the individual market share of not only the equivalent generics but also of the individual share of the branded equivalent products, which goes along with the results found by Grabowski and Vernon (1992). As time goes on, it is possible to see that the individual shares of generic products have been increasing, opposed to the ones of brand-name drugs, as it was forecasted by Barros et al. (2015).

Furthermore, this study also allows us to conclude that counties with lower income and higher unemployment tend to buy more generic drugs, similarly to the results obtained by Dylst et al. (2013) and Vallès et al. (2003). Nevertheless, the fact that a higher education level leads to a lower percentage of generic drugs purchased goes against the previous literature. Note yet that this may be the consequence of the aggregated data used in this study, that may have caused a high correlation between income and education, as previously argued. Despite Himmel et al. (2005) and Heikkilä et al. (2007) arguing the opposite, the data used in this study shows that there are no significant differences on the preferences for generic drugs in people of different ages, similarly to the results obtained by Figueiras et al. (2008) for Portugal.

It was concluded that the homogeneous groups with more generic drugs available are the ones which have a higher proportion of generic sales as well. Besides that, when introducing the same proportion of generic and non-generic drugs in a homogeneous group, in a way that the proportion of generics in the group does not change, the brand-name medicines capture immediately a higher market share than the generic ones. Finally, the last result goes with the conclusion of Aronsson et al (2001) and Carrera and Villas-Boas, (2015) since the larger the price difference between branded products and generics, the higher will be the share of all the equivalent generics. Also notice that these authors observed this considering the shares in value, while this dissertation observed it with respect to the number of units sold.

Notwithstanding, the analysis presented in this thesis has some limitations. The first and the most important one is the fact that the used database had aggregated data into counties. Consequently, it was not possible to characterize each individual consumer and it was needed to work with the average of the socioeconomic variables for each municipality, which prevented us to study the individual preferences. Moreover, this limitation made it impossible to separate the sales covered by the general and special reimbursement regimes. Hence, the analysis was firstly done considering only the general regime for all sales and, in Section 5, only the special regime

was considered. However, it was possible to conclude that there are no significant differences between the two rules.

As a future work, it would be interesting to collect a database with individual data in order to try to solve the limitations previously mentioned. Moreover, it would also be interesting to do the same analysis but considering medicines that are used only to treat chronic and non-chronic diseases separately, such that it would be possible to see if the generic introduction in the market acts differently.

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Appendix

List of the counties' groups

Table 7: Groups of Counties

Group	Counties
1	Abrantes, Albergaria-a-Velha, Albufeira, Alcochete, Alenquer, Almeirim, Amares, Anadia, Angra do Heroísmo, Arcos de Valdevez, Arouca, Azambuja, Baião, Beja, Benavente, Bragança, Câmara de Lobos, Cantanhede, Cartaxo, Celorico de Basto, Chaves, Cinfães, Coruche, Elvas, Entroncamento, Espinho, Esposende, Estarreja, Fundão, Guarda, Ílhavo, Lagoa, Lagos, Lamego, Lourinhã, Machico, Mangualde, Marinha Grande, Mealhada, Mirandela, Monção, Montemor-o-Velho, Odemira, Olhão, Oliveira do Bairro, Oliveira do Hospital, Ourém, Peniche, Ponte de Lima, Portalegre, Porto de Mós, Póvoa de Lanhoso, Ribeira Grande, Rio Maior, Salvaterra de Magos, Santa Cruz, Santiago do Cacém, São João da Madeira, Seia, Silves, Soure, Távira, Tomar, Tondela, Torres Novas, Trofa, Vagos, Vale de Cambra, Vila da Praia da Vitória, Vila Real de Santo António, Vizela
2	Lisboa, Sintra, Vila Nova de Gaia
3	Águeda, Alcobaça, Amarante, Aveiro, Barreiro, Caldas da Rainha, Castelo Branco, Covilhã, Évora, Fafe, Faro, Felgueiras, Figueira da Foz, Funchal, Loulé, Lousada, Mafra, Marco de Canaveses, Moita, Montijo, Oliveira de Azeméis, Ovar, Paços de Ferreira, Palmela, Paredes, Penafiel, Pombal, Ponta Delgada, Portimão, Póvoa de Varzim, Santarém, Santo Tirso, Sesimbra, Torres Vedras, Valongo, Viana do Castelo, Vila do Conde, Vila Real, Vila Verde, Viseu
4	Almada, Amadora, Barcelos, Braga, Cascais, Coimbra, Gondomar, Guimarães, Leiria, Loures, Maia, Matosinhos, Odivelas, Oeiras, Porto, Santa Maria da Feira, Seixal, Setúbal, Vila Franca de Xira, Vila Nova de Famalicão,
5	Aguiar da Beira, Alandroal, Alcácer do Sal, Alcanena, Alcúcutim, Alfândega da Fé, Alijó, Aljezur, Aljustrel, Almeida, Almodôvar, Alpiarça, Alter do Chão, Alvaiázere, Alvito, Ansião, Arganil, Armamar, Arraiolos, Arronches, Arruda dos Vinhos, Avis, Barrancos, Batalha, Belmonte, Bombarral, Borba, Boticas, Cabeceiras de Basto, Cadaval, Calheta (RAA), Calheta (RAM), Caminha, Campo Maior, Carrazeda de Ansiães, Carregal do Sal, Castanheira de Pêra, Castelo de Paiva, Castelo de Vide, Castro Daire, Castro Marim, Castro Verde, Celorico da Beira, Chamusca, Condeixa-a-Nova, Constância, Corvo, Crato, Cuba, Estremoz, Ferreira do Alentejo, Ferreira do Zêzere, Figueira de Castelo Rodrigo, Figueiró dos Vinhos, Fornos de Algodres, Freixo de Espada À Cinta, Fronteira, Gavião, Góis, Golegã, Gouveia, Grândola, Horta, Idanha-a-Nova, Lagoa (RAA), Lajes das Flores, Lajes do Pico, Lousã, Mação, Macedo de Cavaleiros, Madalena, Manteigas, Marvão, Meda, Melgaço, Mértola, Mesão Frio, Mira, Miranda do Corvo, Miranda do Douro, Mogadouro, Moimenta da Beira, Monchique, Mondim de Basto, Monforte, Montalegre, Montemor-o-Novo, Mora, Mortágua, Moura, Mourão, Murça, Murtosa, Nazaré, Nelas, Nisa, Nordeste, Óbidos, Oleiros, Oliveira de Frades, Ourique, Pampilhosa da Serra, Paredes de Coura, Pedrógão Grande, Penacova, Penalva do Castelo, Penamacor, Penedono, Penela, Peso da Régua, Pinhel, Ponta do Sol, Ponte da Barca, Ponte de Sor, Portel, Porto Moniz, Porto Santo, Povoação, Proença-a-Nova, Redondo, Reguengos de Monsaraz, Resende, Ribeira Brava, Ribeira de Pena, Sabrosa, Sabugal, Santa Comba Dão, Santa Cruz da Graciosa, Santa Cruz das Flores, Santa Marta de Penaguião, Santana, São Brás de Alportel, São João da Pesqueira, São Pedro do Sul, São Roque do Pico, São Vicente, Sardoal, Sátão, Sernancelhe, Serpa, Sertã, Sever do Vouga, Sines, Sobral de Monte Agraço, Sousel, Tábua, Tabuaço, Tarouca, Terras de Bouro, Torre de Moncorvo, Trancoso, Valença, Valpaços, Velas, Vendas Novas, Viana do Alentejo, Vidigueira, Vieira do Minho, Vila de Rei, Vila do Bispo, Vila do Porto, Vila Flor, Vila Franca do Campo, Vila Nova da Barquinha, Vila Nova de Cerveira, Vila Nova de Foz Côa, Vila Nova de Paiva, Vila Nova de Poiares, Vila Pouca de Aguiar, Vila Velha de Ródão, Vila Viçosa, Vimioso, Vinhais, Vouzela

Description of the ATC code (first level)

Table 8: ATC code (first level)

ATC - first level	Description
A	Alimentary tract and metabolism
B	Blood and blood forming organs
C	Cardiovascular system
D	Dermatologicals
G	Genito-urinary system and sex hormones
H	Systemic hormonal preparations, excluding sex hormones and insulins
J	Antiinfectives for systemic use
L	Antineoplastic and immunomodulating agents
M	Musculo-skeletal system
N	Nervous system
P	Antiparasitic products, insecticides and repellents
R	Respiratory system
S	Sensory organs
V	Various

Reimbursement Regimes

Table 9: Sales covered by the general reimbursement regime (total market)

Year	Percentage of sales covered by the general regime
2013	64.5%
2014	65.4%
2015	66.4%
2016	67.1%
2017	67.7%

Source: Information system hmR / SICMED - CEFAR Analysis

Notes: This Table shows the percentage of medicine sales in Portugal covered by the general reimbursement regime. The remaining portion stands for the special regime.

Table 10: Outputs from equations (1) and (2), assuming the special reimbursement regime for all sales

Dependent variable: <i>drugshare</i>	(1)		(2)	
	coefficient	<i>p</i> -value	coefficient	<i>p</i> -value
<i>generic</i>	-0.2291	0.000	-0.2624	0.000
log(<i>out pocketuni</i>)	-0.0064	0.000	-0.0064	0.000
<i>newgen</i>	-0.0023	0.000	-0.0036	0.187
<i>newbrand</i>	-0.1676	0.000	-0.1762	0.000
<i>newgen</i> × <i>generic</i>	-0.0025	0.000	-0.0002	0.000
<i>newbrand</i> × <i>generic</i>	0.1735	0.000	0.1850	0.000
<i>youngpeople</i>	-0.0117	0.043	0.0342	0.000
<i>oldpeople</i>	-0.0098	0.012	0.0026	0.507
<i>pharmpc</i>	-2.8069	0.000	-2.4639	0.000
<i>minincome</i>	-0.0270	0.000	-0.0455	0.000
<i>unemp</i>	0.0151	0.000	0.0493	0.000
<i>density</i>	$6.24e^{-7}$	0.000	$4.73e^{-7}$	0.000
<i>income</i>	$-8.26e^{-7}$	0.338	$-3.98e^{-6}$	0.000
<i>noeduc</i>	-0.0148	0.000	-0.0096	0.003
<i>highsch</i>	0.0057	0.127	0.0009	0.800
<i>acdegree</i>	0.0277	0.000	0.0380	0.000
<i>relativeage</i>			-0.0065	0.000
<i>relativeage</i> × <i>generic</i>			0.0109	0.000
<i>constant</i>	0.2603	0.000	0.2645	0.000
Number of observations	9,620,593		9,620,593	
R-squared	0.1613		0.1621	

Notes: The Table shows the obtained coefficients and *p*-values for regressions (1) and (2), run using the OLS estimators and assuming the special reimbursement regime for all the sales.

Table 11: Outputs from equation (4) assuming the special reimbursement regime for all sales

(4)	
Dependent variable: genericshare	
	coefficient <i>p</i> -value
<i>genericprop</i>	0.9123 0.000
<i>newgen</i>	−0.0355 0.000
<i>youngpeople</i>	−0.2049 0.000
<i>oldpeople</i>	−0.1317 0.000
<i>pharmpc</i>	−6.1884 0.006
<i>minincome</i>	−0.1531 0.000
<i>unemp</i>	0.3304 0.000
<i>density</i>	$4.24e^{-6}$ 0.000
<i>income</i>	$-1.32e^{-5}$ 0.004
<i>noeduc</i>	−0.0041 0.814
<i>highsch</i>	0.0187 0.349
<i>acdegree</i>	−0.1171 0.000
<i>A</i>	0.0254 0.000
<i>B</i>	0.0464 0.000
<i>D</i>	−0.0801 0.000
<i>G</i>	−0.1579 0.000
<i>H</i>	−0.1719 0.000
<i>J</i>	−0.0364 0.000
<i>L</i>	0.1428 0.000
<i>M</i>	−0.0237 0.000
<i>N</i>	−0.0083 0.000
<i>R</i>	−0.1712 0.000
<i>S</i>	−0.5793 0.000
<i>pricedif</i>	0.0200 0.000
<i>constant</i>	0.0065 0.568
Number of observations	717,032
R-squared	0.3362

Notes: The Table shows the obtained coefficients and *p*-values for regression (4), run using the OLS estimators and assuming the special reimbursement regime for all the sales.

Tobit outputs

Table 12: Marginal effects from equations (1) and (2) using the Tobit model

Dependent variable: <i>drugshare</i>	(1)		(2)	
	marginal effect	<i>p</i> -value	marginal effect	<i>p</i> -value
<i>generic</i>	-0.3749	0.000	-0.3889	0.000
log(<i>out pocketuni</i>)	-0.0131	0.000	-0.0131	0.000
<i>newgen</i>	0.0005	0.047	-0.0009	0.001
<i>newbrand</i>	-0.3043	0.000	-0.3139	0.000
<i>newgen</i> × <i>generic</i>	-0.0169	0.000	-0.0163	0.000
<i>newbrand</i> × <i>generic</i>	0.2770	0.000	0.2846	0.000
<i>youngpeople</i>	0.0112	0.337	-0.0602	0.000
<i>oldpeople</i>	-0.1484	0.000	-0.1659	0.000
<i>pharmpc</i>	-26.8802	0.000	-27.5104	0.000
<i>minincome</i>	-0.6112	0.000	-0.5800	0.000
<i>unemp</i>	0.5504	0.000	0.4916	0.000
<i>density</i>	$9.31e^{-6}$	0.000	$9.53e^{-6}$	0.000
<i>income</i>	$-3.14e^{-5}$	0.000	$-2.69e^{-5}$	0.000
<i>noeduc</i>	-0.2156	0.000	-0.2265	0.000
<i>highsch</i>	0.0351	0.000	0.0406	0.000
<i>acdegree</i>	0.5208	0.000	0.5048	0.000
<i>relativeage</i>			-0.0080	0.000
<i>relativeage</i> × <i>generic</i>			0.0046	0.000
Number of observations	9,620,593		9,620,593	
Log-likelihood	-4,525,771.8		-4,524,799.5	

Notes: The Table shows the marginal effects and *p*-values for regressions (1) and (2), run using the Tobit model and assuming the general reimbursement regime for all the sales.

Table 13: Marginal effects from equations (3) and (4) using the Tobit model

Dependent variable: genericshare	(3)		(4)	
	marginal effect	p-value	marginal effect	p-value
<i>genericprop</i>	1.3082	0.000	1.0124	0.000
<i>newgen</i>	-0.0401	0.000	-0.0387	0.000
<i>youngpeople</i>	-0.1623	0.000	-0.2089	0.000
<i>oldpeople</i>	-0.1180	0.000	-0.1444	0.000
<i>pharmpc</i>	-13.6149	0.000	-14.2330	0.000
<i>minincome</i>	-0.2410	0.000	-0.2497	0.000
<i>unemp</i>	0.3712	0.000	0.4151	0.000
<i>density</i>	$4.68e^{-6}$	0.000	$5.28e^{-6}$	0.000
<i>income</i>	$-1.38e^{-5}$	0.002	$-1.54e^{-5}$	0.003
<i>noeduc</i>	-0.0399	0.019	-0.0343	0.082
<i>highsch</i>	0.0347	0.071	0.0363	0.107
<i>acdegree</i>	-0.0239	0.099	-0.0550	0.001
<i>A</i>	0.0320	0.000	0.0316	0.000
<i>B</i>	0.0191	0.000	0.0491	0.000
<i>D</i>	-0.0110	0.000	-0.1051	0.000
<i>G</i>	-0.0676	0.000	-0.1810	0.000
<i>H</i>	-0.1273	0.000	-0.1699	0.000
<i>J</i>	-0.0034	0.009	-0.0364	0.000
<i>L</i>	0.1256	0.000	0.1525	0.000
<i>M</i>	0.0160	0.000	-0.0168	0.000
<i>N</i>	-0.0016	0.093	-0.0126	0.000
<i>R</i>	-0.1174	0.000	-0.1695	0.000
<i>S</i>	-0.3492	0.000	-0.6033	0.000
<i>pricedif</i>			0.0213	0.000
Number of observations	933,919		717,032	
Log-likelihood	-316,160.02		-302,487.27	

Notes: The Table shows the marginal effects and *p*-values for regressions (3) and (4), using the Tobit model and assuming the general reimbursement regime for all the sales.