History Dependence and Firm Incentives in Free Contraception Programs*

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Abstract

We study pharmaceutical wholesalers' invest-and-harvest strategies in Finland's birth control pill market. Contraceptives are provided for free at healthcare providers for women under a certain age limit, but after aging out of eligibility, they must pay for the pills entirely out-of-pocket at retail pharmacies. Using individual-level prescription and purchase data, we estimate a structural model to conduct counterfactual analyses. The institutional setting allows for precise identification, separating true history dependence from unobserved heterogeneity. We find strong persistence in demand: individuals continue using the same product from the program, even when cheaper substitutes exist and switching without monetary cost is easily accessible. Firms exploit this history dependence, forgoing early-stage profits to capture path-dependent consumers later in the unregulated retail pharmacy market. In the first counterfactual, where history dependence is removed, prices decrease on average 13 % and firm profits decrease 8 % on average. The estimated investment costs of 0.12 M€ contrasts with the harvesting benefits, for which the estimated upper bound is 0.57 M€. To understand the monetary costs and benefits of the programs for individuals, in the second counterfactual we abolish the hospital pharmacy sector and shift all demand to the retail pharmacy. Individuals end up paying approximately 240 % more for their contraception over their birth control pill use spells.

JEL codes: L65, L11, L21, I18, D12, D22

Keywords: History dependence, pharmaceutical pricing, policy spillovers, birth control

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1 Introduction

Although it is well established that consumers exhibit habit persistence in pharmaceutical demand, less is known about how firms take this into account in pricing. In models with switching costs or brand loyalty, firms face a dynamic trade-off between current pricing and future market power: low prices today can build a locked-in consumer base, while higher future prices extract rents from that base. Despite extensive theoretical work[1] on these mechanisms, empirical evidence with clean identification strategies on how firms operate in health-related markets with true state dependence remains scarce.[2] The pharmaceutical industry offers a compelling context for studying these incentives, as persistent brand choices coexist with tightly regulated and often narrowly defined markets.

Using a structural demand and supply model, we study how history dependence (i.e. habit persistence in choices[3]) in the demand for birth control pills affects pharmaceutical firms' pricing strategies. This question is studied in the context of a unique Finnish policy that offers free contraceptives to women under the age of 25. Once aging out of eligibility, the women must purchase their contraceptives from retail pharmacies and pay the full price out of pocket, because birth control pills are not reimbursed or price regulated. We find young women transitioning from the programs exhibit a strong degree of history dependence.

The institutional setting combined with the demand friction creates a natural two-stage market. In the first stage, firms can strategically invest in capturing market share during a publicly organized free-access phase; in the second stage, they can extract rents from locked-in consumers once demand shifts to the private retail market. We exploit this environment to analyze how firms' pricing behavior responds to predictable consumer transitions and the opportunity to build future market power through initial public procurement. We find firms price well below marginal cost in the hospital market and post higher prices in the retail pharmacy market because of history dependence.

From a policy viewpoint, this means that in a market with switching costs, public policies

[1] See e.g. Beggs and Klemperer (1992), Bergemann and Välimäki (2006), Farrell and Shapiro (1988), and Klemperer (1987a, 1987b).

[2] Examples include Janssen (2023) who studies pharmaceuticals, Feng and Maini (2024) studying pharmacies and pharmacy benefit managers and Handel (2013) studying health insurance.

[3] We use the term history dependence interchangeably with the terms such as state dependence or demand inertia describing the same phenomenon of habit persistence in choices.

aimed at young individuals can have long-term effects on demand and spillover effects to retail markets, affecting the market equilibrium. When policymakers make decisions about subsidies and public provision, they need to account not only for their immediate impacts, but also for how they interact with firm incentives and consumer demand over time, shaping trajectories of demand and competition.

However, estimating true history dependence is demanding, and the main challenge lies in distinguishing it from unobserved heterogeneity. Following Heckman (1981), true state dependence occurs when experiencing an event genuinely changes future behavior, so individuals who experience it act differently than those who do not. Spurious state dependence arises when unobserved, persistent differences between individuals make past experience appear to affect future behavior, even though it does not. To be able to estimate true state dependence, most models[4] require that the individual's initial choice be exogenous — unaffected by prior states or correlated preferences (Heckman, 1981). Our institutional setting provides a plausibly exogenous initial choice, allowing us to separate true history dependence from unobserved heterogeneity. The initial choice is exogenous in the sense that products available in the free contraception programs are determined by hospital pharmacy procurements and physicians or individuals cannot choose from the full set of available products in the substitution group.[5] Furthermore, within our market definition, the substitution group, products are perfect substitutes to which individuals are unlikely to have any unobserved match qualities.

We utilize comprehensive, individual-level prescription and purchase data from Finland between 2015–2022. Our descriptive and reduced form analyses highlight two facts. Firstly, there is a large discrepancy between the prices of the same products in the retail pharmacy markets and the hospital pharmacy markets, i.e. in the free contraceptive programs. On average, the products are 80 % cheaper in the hospital pharmacies than in retail pharmacies, and in some cases, products may even be 99.9 % cheaper in the hospital pharmacy markets.

[4] A common alternative is outlined by Honoré and Kyriazidou (2000), where unobserved preferences are captured by individual and product fixed effects. It requires product characteristics such as prices to remain constant, which is rarely the case in health-related markets. This condition is relaxed in more recent work by Dano (2023).

[5] A substitution group is a set of medically identical drugs that are interchangeable, meaning a pharmacist can substitute one for another if the patient so wishes.

Products found in the hospital pharmacies are also often branded products, which are the most expensive alternatives in the retail pharmacy. Secondly, individuals are unlikely to switch from the product they have received for free. In free programs, most individuals initially receive a product that will be expensive in the retail pharmacy. Of these individuals, 88 % end up purchasing the same product on their first visit to a retail pharmacy after exiting the free program.

We estimate a discrete choice mixed logit demand model accounting for price endogeneity and disentangling history dependence from unobserved heterogeneity by fulfilling the exogenous initial choice condition. We use moving from enrollment in the free program to the pharmacy-administered use of contraceptives to identify history dependence. Although individuals are somewhat sensitive to prices, they exhibit a strong pattern of history dependence. Furthermore, consumers have rather inelastic demand, especially for branded products, which are most prominently distributed in the programs with free products.

With the parameters from the demand model, we are able to calculate marginal costs assuming firms compete Bertrand-Nash in the retail pharmacy market. Marginal cost estimates reveal that products are sold below marginal cost in the hospital markets. Markups are on average 70 % in the retail pharmacy sector and -68 % in the hospital pharmacy sector.[6]

We currently provide two counterfactuals. In the first counterfactual, we eliminate history dependence and re-estimate the prices in the retail pharmacy market. This counterfactual essentially quantifies the maximum benefits firms are able to reap from having invested in capturing clientele during the period individuals are eligible for free contraceptives. When all history dependence is removed, prices of products decrease on average 13 %.[7] The decreasing prices and changing market shares result in a 8 % average decrease in annual profits. For the firms selling in both sectors, retail pharmacy profits

[6]Dubois and Lasio (2018) and Janssen (2023) document slightly lower retail markups, but their analyses are from price regulated markets. Pharmaceutical markets are characterized by high fixed costs and uncertainty, whereas marginal costs are typically low.

[7]This should be viewed as an upper bound for how much prices may decrease. Removing history dependence essentially removes both the history dependence resulting from previous program-use and any natural history dependence that could result from making purchase decisions multiple times in a sequence.

decrease on average 13.5 %. Removing history dependence results in individuals paying on average 7 euros less for each package and 44 euros less over the course of one year.

With results from the first counterfactual, we are also able to calculate the cost of and return on investment to the hospital sector from marginal costs, hospital pharmacy prices and market shares. The annual investment cost of selling to the hospital pharmacy sector is on average 0.12 million euros. The annual benefit in the retail pharmacy sector from providing free birth control pills through the hospital market is 0.57 million euros. This calculation provides an upper bound for the monetary benefits firms are able to gain from using history dependence to their advantage.

The second counterfactual aims to quantify the monetary costs and benefits of programs to individuals. While programs have unquestionable benefits for health and well-being, they also affect the sexual health-related costs born by individuals. We are also able to make similar assessments for firms and the government. In the second counterfactual, we abolish the hospital market and move all consumption to the retail pharmacy market. Without the programs, individuals would spend on average approximately 240 % more on their birth control over the spells of birth control pill use observed, i.e. from age 15 up to age 26. For firms, annual revenue increases on average 1.5 million euros and profits increase on average 0.95 million euros due to the imposed shift in demand. For the government, moving demand to the retail pharmacy market increases revenues from pharmacy taxes and decreases expenditure on pharmaceuticals distributed through the free programs in hospital pharmacies.

Related literature Our primary contribution is to provide evidence on how firms price in markets with switching costs. The existing literature on pharmaceutical markets is limited to work by Janssen (2023), who studies history dependence and firm pricing in the presence of price regulation in Swedish drug markets. The paper produces counterfactuals where the procurement periods of retail pharmacy drugs are altered, but contrary to our paper, does not provide counterfactual evidence on removing history dependence and examining its impact on prices. Our approach also differs from Janssen's paper through the identification assumptions. Whereas Janssen (2023) must make informational

assumptions, our identification strategy hinges on a plausibly exogenous initial choice, that does not require any informational assumptions and is very likely uncorrelated with tastes. Other examples of papers studying history dependence and forming pricing-related counterfactuals are Feng and Maini (2024), who examine the role of pharmacy benefit managers in pharmacies, and MacKay and Remer (2024), who analyze how consumer inertia shapes dynamic pricing and merger effects in retail gasoline markets.

Secondly, this paper also contributes to the understanding of spillovers from government policies in markets with switching costs. As mentioned, the free contraception policy is implemented through the hospital pharmacies, but has strong spillover effects in the retail pharmacy. In the presence of history dependence, the spillover effects may become especially persistent. To our knowledge, this is the first paper to evaluate such spillovers in pharmaceutical markets.

More broadly, we relate to the literature estimating history dependence in health-related markets. History dependence has been studied in drug markets both structurally (Feng, 2022; Ito et al., 2020; Janssen, 2023) and with other methods (Ching, 2010; Granlund, 2021; Janssen & Granlund, 2023). Studies concerning different types of insurance markets include health insurance (Abaluck & Gruber, 2023; Boonen et al., 2016; Croes et al., 2022; Handel, 2013; Pakes et al., 2021), Medicare part D (Abaluck & Gruber, 2011; Einav et al., 2015; Ericson, 2014; Ketcham et al., 2015; Polyakova, 2016), drug insurance for the elderly (Abaluck & Gruber, 2016) and retirement plans (Madrian & Shea, 2001). Examples from hospital markets include Irace (2018), Jung et al. (2011), and Raval and Rosenbaum (2018).

We also relate to literature on state dependence analyzing what the source of demand frictions is. Possible sources include intangible switching costs such as brand loyalty or inattention[8], and tangible switching costs[9]. In the case of birth control pill markets, tangible switching costs or inattention are unlikely sources of history dependence. Pharmacists are required by law to offer a cheaper substitute if available and switching in the pharmacy does

[8]Inattention as a source has been studied for example in hospital choice (Anell et al., 2021), mobile subscriptions (Reme et al., 2022) and newspaper subscriptions (Miller et al., 2023).

[9]There is a vast literature on switching costs in various markets. Examples of tangible switching costs in health-related markets include for example multiple studies on Medicare Part D (Ericson, 2014; Ketcham et al., 2012; Polyakova, 2016). Earlier work also notes that inertia may be resulting from several sources of frictions (Ericson, 2014; Handel, 2013).

not bear monetary costs to the individual. Brand loyalty or premia has been studied in for example pharmaceuticals (Crawford & Shum, 2005; Grabowski & Vernon, 1992; Janssen, 2023), insurance markets (Ericson, 2014) and consumer packaged goods (Bronnenberg et al., 2012; Dubé et al., 2010; Kong et al., 2024; Levine & Seiler, 2023; Shum, 2004).

In addition to our focus on firm strategies, choice frictions and the interplay of the two, we contribute to the policy-relevant literature on organizing free contraception. Affordable contraception is a central issue for women's health, as unwanted pregnancies—particularly in early adulthood—can generate substantial health, social, and mental costs. Studies show that providing contraceptives free of charge reduces unwanted and teen pregnancies (Fisher et al., 2019; Gyllenberg et al., 2018; Kearney & Levine, 2009; Lindo & Packham, 2017; Peipert et al., 2012), and that lowering out-of-pocket costs increases uptake and continuation (Bailey et al., 2023; Luca et al., 2021; Packham, 2017). However, most research evaluates individual interventions ex post and rarely assesses alternative program designs. We study a universal, population-level policy in Finnish municipalities that provides free contraception to all young women in specific age groups, enabling us to evaluate behavioral and pricing effects while constructing counterfactuals to explore alternative organizational designs - a perspective largely absent in prior work.

The remainder of the paper proceeds as follows. In Section 2, we introduce the relevant institutional background regarding free contraception programs, hospital pharmacies and retail pharmacies. In Section 3, we describe the data and sample. In Section 4, we present descriptive analysis on the individuals in the sample as well as the pharmaceuticals. In Section 5, we present the reduced form model and its results. In Section 6, we outlay the structural demand and supply models. Section 7 displays the results of these models as well as the counterfactuals. Section 8 concludes the paper with a discussion.

2 Institutional background

2.1 Free contraception programs in Finland

2.1.1 Adoption of the programs

This papers studies free contraception programs Finnish municipalities have adopted between 2014–2022. In these programs, contraceptives are dispensed by healthcare providers to young females free of charge. Age limits vary by municipality and typically range between 20–25 years. There is no minimum age for use, but we use the age of 15 as the lower threshold.[10] Programs offer different types of birth control methods such as pills, IUDs, patches, capsules and rings. Products are generally distributed to individuals in the programs through health service providers, not retail pharmacies. The products available in each municipality are dictated by procurement auctions in hospital pharmacies. This system is further described in Section 2.2.

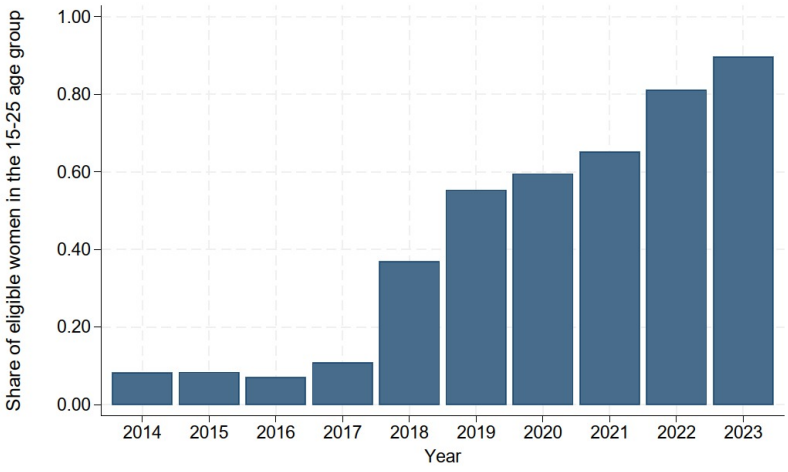


Figure 1: Share of women aged 15–25 residing in municipalities with programs

Free contraception programs have existed in Finland since the early 2000s, but they started gaining popularity after 2015 and had been implemented in almost all municipalities by 2024.[11] Before 2022, each municipality decided on its own or with

[10] According to the Finnish Current Care Guidelines of Duodecim (2020), usually teens aged 15 are usually considered to be capable of making their own decisions regarding care.

[11] There are a few municipalities that have had programs since the 90's, and many municipalities that have offered free contraceptives in some form. Offering the first IUD for free has been common in many municipalities since the early 2000s.

neighboring municipalities whether to offer free contraceptives. Our definition of offering free contraceptives is that the municipality needs to offer several methods for over a consecutive 6-month period.[12] Figure 1 depicts the share of women aged 15-25 that are residing in municipalities with free contraceptives programs during 2015–2022, which is our sample period.[13] Figure 2 shows the maps of municipalities with programs in 2016, 2020 and 2024.

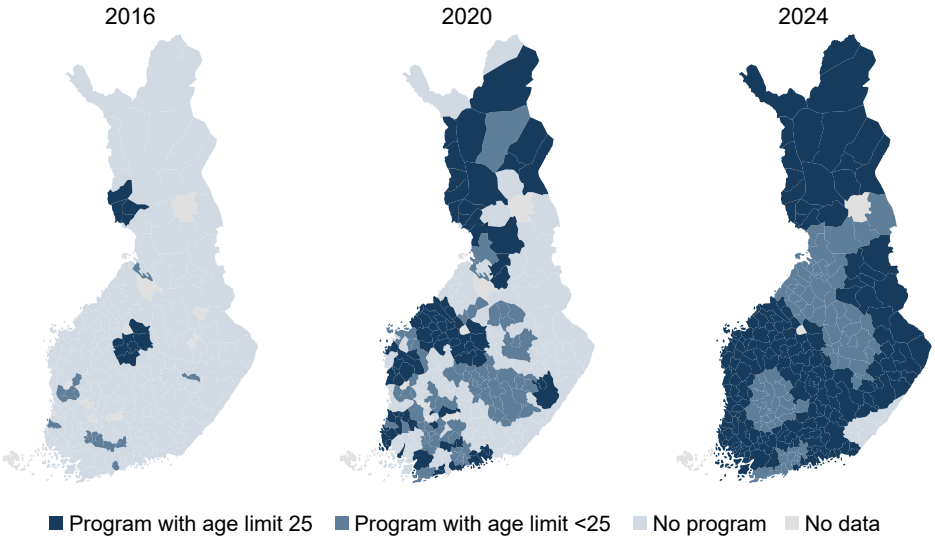


Figure 2: Implementation of programs between 2016–2024

The adoption of the programs sped rapidly beginning in 2022, when the national pilot was introduced and coordinated by the Finnish Institute for Health and Welfare (THL) due to growing inequality concerns. In 2023 almost all young women were eligible and living in a municipality offering a program. THL stated that the most important things about sexual and reproductive health services are availability and access, and municipal programs had contributed to inequality among young women residing in different geographical locations. Municipalities and cities from all over Finland participated in the pilot. As a part of the pilot, municipalities with their own previously founded programs

[12]There are some municipalities stating they offer free contraception, but only offer 3–6 moths of products for the individual to get started.

[13]The electronic prescription system was implemented in 2014, but not all municipalities adopted it right away, hence our sample begins from 2015.

also harmonized their practices with neighboring municipalities. We do not include the national pilot years in our sample for a cleaner identification: the pilot included distributing contraceptives free of charge, but also raising awareness of the importance of sexual and reproductive health in well-being.[14] It may therefore have affected some factors relating to access to care. In addition to the contraceptives, the participating municipalities provided sexual and reproductive health counseling as well as STD testing.

2.1.2 Program pathway

Free contraception programs offer different contraceptive methods to young women without any out-of-pocket costs.[15] Typically, a municipality offering such a program will decide on an age threshold between a minimum of 20 years and a maximum of 25 years. Again, as a lower threshold we use age 15. Most municipalities choose to provide contraceptives free of charge until the individual goes over the age limit.[16] Available methods include short-acting methods such as pills, rings, patches and non-hormonal methods as well as long-acting reversible methods such as capsules and hormonal or non-hormonal intrauterine devices. It is also common for municipalities to offer the program to students studying in the municipality, but residing elsewhere.

There are some institutional features that are key to our identification strategy, and they revolve around the exogeneity of the initial choice. Firstly, the individual cannot pick the doctor they want: the maternity clinics, health centers and student healthcare providing oral contraceptives free of charge assign the individual to a doctor or prescribing nurse randomly. An eligible individual typically first visits a prescribing nurse or a nurse who can refer them to a doctor. These visits can be organized through booked appointments or walk-in services and they are most commonly situated in centralized maternity and sexual

[14] Pilot participation was decided at the municipality level in some regions and at the hospital district level in others. Some municipalities had already offered partial free programs, which were extended or modified during the pilot, although it was intended for areas without prior programs. Regions joined the pilot between January and October 2022, implementing programs from spring 2022 to January 2023. By 2025, only one of the 21 well-being services counties did not offer free contraceptives to young women, and in 2024 most counties harmonized municipal program practices.

[15] This means there are no out-of-pocket costs resulting from the visits to the health services or from the contraceptives received.

[16] Some municipalities provide free contraceptives for only 3–12 months rather than until the individuals age out completely. These municipalities are excluded from our sample due to difficulties tracking the individuals in the register data.

health clinics or in student healthcare services. The initial visit includes a health check and conversations about sexual health. In many municipalities, currently being sexually active is not a requirement for starting contraception through the program.

Secondly, the doctors cannot pick which product in a substitution group[17] of birth control pills they will give to the individual. The products available at each clinic are determined by procurement auctions at the hospital pharmacies, described further in Section 2.2. The doctor can naturally choose which specific method or active ingredient the individual should use and this may be a choice the individual can also influence, but neither can specifically choose the product. After the appropriate method has been agreed upon, the individual is immediately eligible to receive the pharmaceuticals or contraceptive products. At this stage, some of the municipalities have a practice of also writing a prescription for the product the individual is receiving for free.[18] According to interviews with healthcare professionals from program municipalities, the individuals typically receive doses for 3 to 6 months at a time.

Some municipalities have a check up for the individuals approximately 3 months after the initial appointment to make sure the contraceptives are working and suitable for the individual. If all is well, they can keep using the same product and are eligible to receive more. Most municipalities offer the service as unlimited until one reaches the age threshold. After the individuals age out of eligibility, they are left with a prescription they can use in the retail pharmacy to purchase the same product. Once the prescription runs out, they can request it to be renewed electronically.[19] This continuum from the free program to purchases made in the retail pharmacy is essential to our identification: the individuals will be left with a prescription for the same product they have used in the program and we will observe them making purchases.

[17] A substitution group is a set of interchangeable medicines with the same active substance. The active substance (ATC5 level) is the chemical compound in a medicine, classified under the WHO's Anatomical Therapeutic Chemical system, where higher levels (ATC2–4) denote broader pharmacological subgroups.

[18] Interviews with health professionals suggest varying reasons for writing prescriptions: to ensure all medication records are stored in the prescription database, or so individuals can buy replacement doses from pharmacies if they lose their pills.

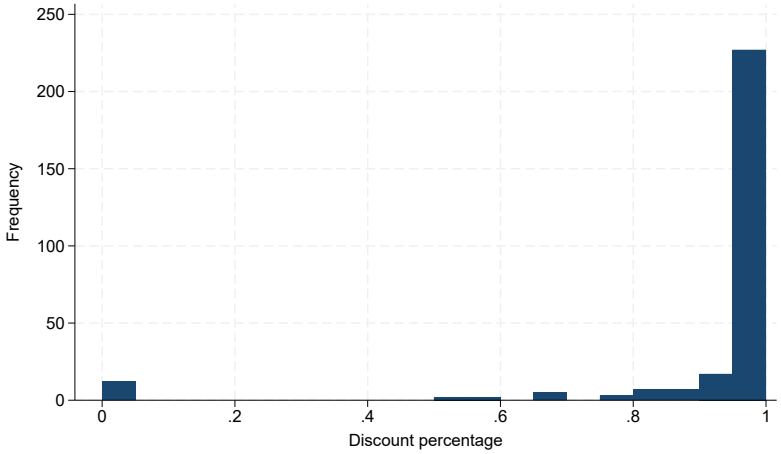
[19] In the public sector, renewing the prescription online is free. In the private sector or in occupational healthcare, you or your employer may have to pay a small fee. Free programs are only organized through the public sector.

2.2 Hospital pharmacies and free program pharmaceuticals

Hospital pharmacies have an essential role in supplying the healthcare service providers with the pharmaceuticals that are distributed to individuals in the free programs. Hospital pharmacy prices and the mechanisms that determine them differ from those of retail pharmacies, which are discussed further in Section 2.3.

In the free programs, the products the individuals receive are free of charge to them, but have been purchased by the health care provider from a regional hospital pharmacy. Hospital pharmacies purchase their products directly from pharmaceutical companies or their representatives acting as wholesalers in procurement auctions and further price negotiations. This is why the hospital pharmacy wholesale price of a given contraceptive pill package will differ greatly from the purchase price for an individual buying the product from a retail pharmacy.

Whereas in retail pharmacies prescription drug prices are set nationally, in hospital pharmacies prices may vary by region. The contraceptive products offered in the free programs by healthcare providers are procured regionally, usually through either hospital district-wide or larger scale joint procurements. Table 17 in Appendix B provides information of the joint procurements in the Finnish former hospital districts and current well-being services counties. Although large areas procure the pharmaceuticals, in practice the municipalities and their healthcare providers as well as hospital pharmacies are responsible for choosing which of the procured products they want to include in their offering. This will result in variation of the choice set for the prescribing physicians in different municipalities. We have collected data on the available products from each municipality for our sample years.



NOTE: The graph presents the discount percentages from 0 to 99.9 % for products bought by hospital pharmacies from wholesalers. Some hospital pharmacies do not report their discount percentages, hence they are not available for products in all hospital pharmacies.

Figure 3: Distribution of discount percentages available in hospital pharmacy data

The procurements for all hospital drugs resemble sealed bid auctions, that determine which products are included in the selection of the hospital pharmacies in the region and what the prices of those products will be. The clients of hospital pharmacies are the public healthcare providers in the region. The procurements are governed by the Act on Public Contracts and Competition law (Siikanen, 2019).The auctions are typically organized for each active ingredient and there may be multiple winners. This can be for example due to the hospitals wanting different alternatives of the same active ingredients to ensure stock in the case of shortages or such. Firms have a time window of 22 or 45 days to submit their bids depending on the publicizing of the procurement (Fimea, 2016). The procurement contracts last typically 1-3 years, and it is common that the entire selection of pharmaceuticals is procured at the same point in time. Additional procurements may also take place throughout the contract period. Prices must be strictly positive.

The winner of the procurement is typically the product with the lowest price, but if all bids were to exceed wholesale prices in retail pharmacies, hospitals may also choose to buy their products from the wholesaler (Siikanen, 2019). In the case of contraceptives, the prices are generally much lower than the wholesale prices. A key feature in the procurements of birth control pills is that they may be sold to the hospital pharmacies using two prices: firms may price separately packages meant for those that are starting their contraception

and those that are continuing it. The starter package prices are close to zero and user package prices higher, but still significantly below retail pharmacy price. We only observe the winning bid or bids.

The difference between wholesale prices and bids are denoted by a so-called discount percentage. The products cannot be given to the hospitals free of charge or with negative prices, but in practice there are many examples of firms selling their contraceptive pharmaceuticals to the hospital pharmacies and the pharmacies distributing them further to hospital with the price of just a few cents. Discount percentages in the contraceptives in our data range from 0 to 99 percent. As indicated in Figure 3, most products are sold with a discount percentage that is above 0 and a very large share of all products have a discount percentage that is close to 100 percent.

2.3 Retail pharmacies

After aging out of eligibility, individuals must purchase their birth control pills from retail pharmacies, just like any other pharmaceuticals they would purchase. Prices in retail pharmacies are national and set through a different mechanism than in hospital pharmacies.

In the retail pharmacy, firms selling birth control pills can set the whole price freely.[20] Although the pharmaceutical markets in Finland are known to be home to strict price regulation,[21] price regulation is not enforced on birth control pills: contraception does not treat a disease, so contraceptives cannot be reimbursed nor price regulated.[22]

The pharmaceutical firms set wholesale prices at which the products are sold to the retail pharmacies. The retail price the consumer will pay is determined through a tiered pricing schedule of the regulated retail pharmacy markup, shown in Table 1. Additionally, all prescription drugs have a 10 % value added tax that is calculated from the retail price.

[20]The products must have a marketing authorisation. If the product has been authorised for sale elsewhere in the EU, like the birth control pills studied in this paper, this is a straightforward process. More information on the process can be found in Appendix A.2.

[21]See e.g. Kortelainen et al. (2023).

[22]There are currently only four oral contraceptives that have been accepted for reimbursement. They are often used for the treatment of endometriosis, a chronic disease associated with severe, life-impacting pain in general as well as during periods and sexual intercourse. (Pharmaceuticals Pricing Board, 2024b; WHO, 2023)

Table 1: Retail pricing formulas of prescription drugs

	Wholesale price	Retail price
After 01/01/2015	0–7.49	1.42 × wholesale price
	7.50–39.99	1.35 × wholesale price + 0.52 €
	40.00–99.99	1.24 × wholesale price + 4.92 €
	100.00–399.99	1.15 × wholesale price + 13.92 €
	400.00–1 499.99	1.10 × wholesale price + 33.92 €
	>1 500.00	1.00 × wholesale price + 183.92 €

NOTE: All price figures are in euros (€).

While prices are not regulated through a typical reference pricing scheme[23], products are still sorted into substitution groups, which allows for generic substitution. Generic substitution is the pharmacy-administered substitution that takes place between the products that are deemed as substitutes by the Finnish Medicines Agency (Fimea).

When an individual ages out and receives a prescription for the product they have used in the free program, they will be able to use that to purchase that given product or any other product in the same substitution group once they visit the retail pharmacy. Substitution is only possible within a substitution group, which is the market definition in this paper. This type of substitution is costless to the individual and does not require altering the prescription in any way.

Table 2 shows an example of what a substitution group may look like. If an individual would have a prescription for Sandoz's Tasminetta, which is the most expensive alternative in its substitution group with the price of 24.50 euros, the pharmacist would in the retail pharmacy would ask the customer if she wants to substitute to the cheapest option, in this case Orifarm's Tasminetta, priced at 23.80 euros.[24]

[23]The reference pricing system is imposed on all reimbursed drugs in Finland. More information is available on the reference pricing system in Appendix A.1 and on reimbursement in Appendix A.3.

[24]Prices retrieved from Yliopiston Apteekki (https://www.yliopistonapteekki.fi/) on 15.10.2025.

Table 2: Example of two substitution groups from ATC5 G03AA12 containing drospirenone and ethinyl estradiol (Fimea, 2025a)

Substitution group	Product name	Strength	Format	Parallel import	Marketing authorisation holder	Price €
1360	Yasmin	0.03mg/3mg	Coated tablet	Yes	Abacus Medicine A/S	34.61
1360	Yasmin	0.03mg/3mg	Coated tablet	No	Bayer Oy	35.37
1360	Yasmin	0.03mg/3mg	Coated tablet	Yes	Orifarm Oy	34.61
1360	Yasmin	0.03mg/3mg	Coated tablet	Yes	Paranova Oy	34.61
2280	Tasminetta	0.03mg/3mg	Coated tablet	No	Sandoz A/S	24.50
2280	Tasminetta	0.03mg/3mg	Coated tablet	Yes	Orifarm Oy	23.80

NOTE: The substitution groups here do not necessarily correspond to substitution groups included in the sample of this paper. Prices are retrieved from the online pharmacy Yliopiston apteekki on 30.10.2025 and they are retail pharmacy prices.

Substitution groups are formed within ATC5 groups by grouping similar products together. Because there is no price regulation, the groups are often formed based on the brands sold and contain the branded drug and parallel imports. A parallel import is a branded drug from another country within the European Economic Area, where it is sold at a lower price. These medicines are typically re-packaged and re-labeled for sale in the importing country, often at a lower cost than locally distributed products. As one can notice from Table 2, both substitution groups contain drospirenone and ethinyl estradiol with strengths 0.03mg/3mg. Typically a substitution group will be formed based on active ingredient, strength, format and package size, so formulating substitution groups based on brand is not typical. It also adds a non-competitive flare to the market as whole: substitution between substitution groups is not possible even when they have the same strengths of the same active ingredients.

Finally, it should be noted that advertising of prescription drugs is prohibited in Finland and thus birth control pills or any other methods of hormonal birth control cannot be advertised. However, there is anecdotal evidence that drug manufacturers have launched marketing campaigns about the importance of contraception over the sample years.[25] Unfortunately, there is no data on the available services or the general advertisement campaigns firms have run. Additionally, physicians may be subject to direct advertising from drug marketing authorisation holders, but there is no data

[25]For example, the drug company Bayer manufacturing the majority of the hormonal and non-hormonal intrauterine devices sold in Finland has launched multiple information campaigns about the use of IUDs. In 2025, they are hosting an information website called Ehkäisynetti (Birth Control Web) meant for spreading awareness of hormonal contraceptive methods (see Appendix A.4).

available on the matter.

3 Data

We utilize multiple sets of data: electronic prescription and purchase data from Kanta services, FOLK data from Statistics Finland, data on prices and quantities collected from all hospital pharmacies in Finland, and data on free program guidelines collected from Finnish municipalities.

The main data set is from the Kanta services, which is the nationwide electronic prescription register in Finland. It contains data on prescriptions and purchases and covers years 2015–2022. The data consists of variables on purchase price, reimbursement details, product details and prescription details. The sample includes almost all physicians and their patients in Finland.[26] It is constructed by first taking a random sample that covers $\frac{2}{3}$ of all physicians in Finland and all the prescriptions of their patients. For these patients, all other prescriptions given by other physicians not in the originally randomly chosen $\frac{2}{3}$ group are also included. In the end, the sample covers almost all prescriptions in Finland, although the exact share is difficult to determine.

Our main data set is the prescription data, so we cannot identify the use of long-term reversible contraceptive methods such as IUDs or implants, that are usually administered at a doctor's appointment without a prescription. We are also unable to identify the use of non-pharmaceutical contraception measures such as condoms, fertility awareness-based methods or abstinence, and treat these as the outside option in our demand model. These types of contraception methods are not of particular interest in terms of our research question, but need to be taken into account when assessing the policy implications of the findings.

We link the individuals in the above-mentioned data to other data sets provided by Statistics Finland. These data sets include detailed information on individual characteristics such as the geographic location, education, labor market status and earnings as well as family composition of the patients.

In addition to the Kanta and Statistics Finland data sets, we have collected two sets of

[26] At the time of acquiring the data, The Social Insurance Institution of Finland, who is the data owner and controller, only allowed the data to be used as representative samples.

data from all Finnish municipalities and all hospital pharmacies. For the municipality data, a questionnaire was sent to all 292 municipalities in mainland Finland and answers were received from 285 municipalities. The municipalities had to answer questions related to for example the starting times of the free programs, eligibility conditions related to age and municipality of residence, offered contraception methods and products and use of electronic prescriptions with contraceptive pills. As a result of the questionnaire, we have a dataset for each year between 2014–2024 indicating what has been offered and to whom in each municipality.

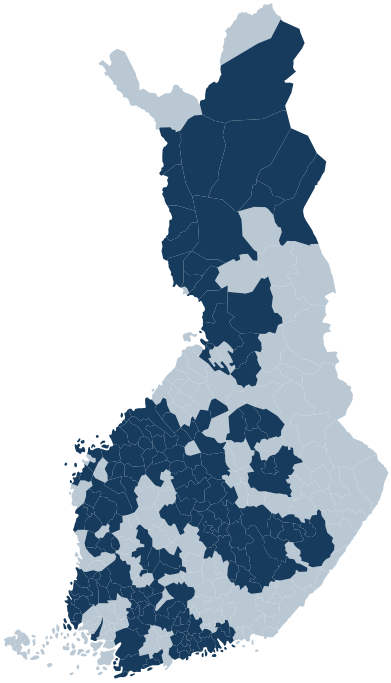


Figure 4: Municipalities in the sample

The hospital pharmacy data questionnaires were sent to each hospital pharmacy in Finland. The data sets contain product-specific prices and quantities of these products delivered to health care providers in the region of the hospital pharmacy from each year there has been free programs running in the municipalities of the region. The prices are the prices from procurement auctions.[27] From some of the hospital pharmacies, we also

[27]The hospital pharmacy sales to public healthcare providers are best described as moving money from one pocket to another, because both the pharmacies and the hospitals operate under the mutual budget of the former hospital district or current well-being services counties. Each pharmacy has their own agreements on

obtained the exact discount percentages negotiated between the procuring pharmacy and pharmaceutical wholesaler or drug company.

We currently include 158 municipalities with free contraception programs that are located in different parts of Finland. In these 158 municipalities, there were 323 250 women aged 15–28 in 2020. In 65 of these municipalities, the age limit in 2020 for free contraception was 20 years, in 1 it was 21, in 7 it was 22 and in 78 municipalities it was 25. The map of the municipalities in the sample is shown in Figure 4. We have data from municipalities in each of the five joint procurement areas in Finland, as shown in Table 17 in Appendix B.

We identify individuals in the free programs in two different ways. Firstly, we identify those that receive their prescription already during the free program as follows. We take all oral contraceptive prescriptions of individuals under the municipality-specific age threshold that have not been dispensed in the retail pharmacy before the individual crosses the age threshold. This is because even those receiving an electronic prescription have to collect the free contraceptive products from health care providers. Secondly, we identify those that receive their prescription upon exiting the free program. We identify these individuals from the data as ones that receive a prescription around their birthday when exiting a program, conditioned we do not observe a previous birth control pill prescription for them. Free programs operate only through the public sector.

We observe the sector of the prescribing entity (public or private) and only use the prescriptions from public health care providers. We are able to observe both the prescriptions and the commencing purchases related to that prescription. The individuals may appear in the sample for different lengths of time, as some may eventually stop using oral contraceptives. We aggregate the prescription and purchase data to a monthly level. Oral contraceptives are generally sold in 1-month, 3-month or 6-month packages. In the sample, most individuals have at maximum one purchase per month. Cases where an individual has multiple purchases within a month can be attributed to purchasing one month packages at a time around the start and end of a given month. Almost all

what type of margins to include and there are significant differences between the counties. We use margin-free prices in our analysis, because they are the prices that are paid to the manufacturers and matter from a public finance viewpoint.

individuals buy their products in larger than 1-month packages.

We observe 42 344 individuals receiving a prescription in the free program and making at least two purchases in the retail pharmacy after they have gone over the age limits of the program. These individuals have prescriptions from the public sector for 49 products from 4 different ATC5 classes.[28] An ATC5 may have several substitution groups within it. The substitution groups determine the choice sets of the individuals. The number of products can vary within a substitution group over time, but only substitution groups with at least two products in each sample period have been included in the analysis. Products in a substitution group may differ from each other in brands, package sizes, manufacturer and/or marketing authorization holder identity. Otherwise products will be rather homogeneous, especially within the substitution groups, as is often the case in the pharmaceutical markets. Descriptive statistics on the individuals and products in the sample are presented in Section 4.

We will be able to identify true state dependence by observing how the product obtained in the free program affects the first choice in the retail pharmacy upon aging out and exiting the free program. We then utilize the estimated true state dependence parameter to estimate demand in the retail pharmacy sector for the whole population of women receiving prescriptions from the public sector. This sample includes 156 252 individuals.

4 Descriptive statistics

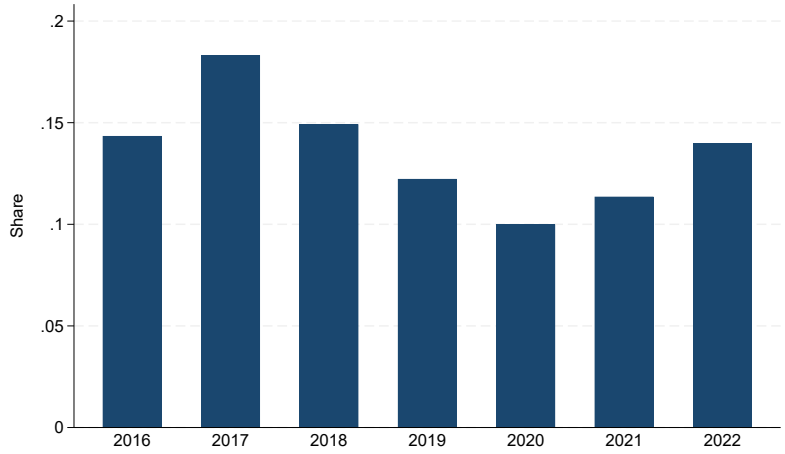
4.1 Individuals in the free programs

4.1.1 Characteristics

In this section we provide some descriptive statistics of individuals in the sample and how they compare to other relevant groups of young women. We also provide descriptive evidence for the presence of history dependence in the birth control pill markets. Descriptive statistics about the firms and their products supplied in said markets are shown in Section 4.3.

[28] Due to data use restrictions, we are not able to reveal the exact ATC5s included in the sample. However, the included ATC5 classes are among the most sold oral contraceptives and capture the majority of the birth control pill market in Finland.

Our observation period stretches over 2015–2022. Our data shows that approximately 24 % of 15–25 year olds were using birth control pills between 2015–2022.[29]



NOTE: The Y-axis shows the share of 15–25-year-olds with a public-sector birth control pill prescription among residents of municipalities with programs. Each bar represents the share across all municipalities with a program.

Figure 5: Share of 15–25 year olds with prescription in municipalities with running program by year

To understand take-up in the programs, we analyze the share of eligible individuals with a prescription of all the 15-25 year olds in municipalities with running programs. This is shown for years 2015–2022 in Figure 5, showing that approximately 12–18 percent of 15–25 year olds in program municipalities have a birth control prescription between 2016–2022. In Figure 5 in 2020, the number of visits to student health care in Finland declined by 15 % compared to the previous year (THL, 2025), likely due to COVID-19. Overall, our data indicates there were 11 % less birth control pill prescriptions in 2020 compared to 2019 from the public sector and 10 % less from the private sector.[30]

Table 3 shows descriptive statistics for 15–25 year old women using birth control pills as their primary method of contraception and those not using birth control pills.[31] The two

[29] According to a survey by Family Federation of Finland (2019), approximately 39 % of Finnish women aged 18–34 used birth control pills as their method of contraception in the last time they had sexual intercourse. Our figure of 24 % corresponds to the share of the whole population, which is larger than the population of those sexually active.

[30] Interviews with program municipalities indicate that although COVID-19 may have affected access to care for new individuals, the distribution of birth control pills to existing program enrollees did not cease.

[31] The former group is conditioned on them having a prescription. The latter group may include individuals using contraceptive rings and patches or non-identifiable methods, include for example IUDs, capsules,

groups are rather similar in their mean age, marital status and geographic location as well as education characteristics. They do, however, differ somewhat in their family composition, language and income or earnings. A much larger share of those not using birth control pills have children.

Table 3: Descriptive statistics of birth control pill users and others in age group 15–25

	Birth control pill users	Other women
	(1)	(2)
Age	20.98	19.84
Unmarried (%)	97.50	96.67
Cohabiting w/o children (%)	39.54	20.98
Born in Finland (%)	95.62	90.70
Finnish citizen (%)	97.92	94.05
Finnish speaking (%)	90.04	84.29
Household size	2.25	2.81
Lives in city (%)	82.82	80.15
Lives in countryside (%)	8.33	6.95
Bachelor's degree or higher (%)	16.68	15.06
General upper secondary diploma (%)	62.61	59.23
Employment months in a year	9.86	9.31
Unemployment months in a year	3.53	3.83
Disposable income	14 601	11 724
Earnings	14 993	11 737
Received student allowance (%)	63.10	58.87
Debt	20 814	20 610
Observations	47 943	280 587

NOTE: Column (1) shows statistics for individuals aged 15–25 who have a birth control pill prescription in the Kanta e-prescription register. Column (2) shows statistics for individuals identified in Statistics Finland's population data. All statistics are calculated based on population data statistics, which prescription data can be merged to.

barrier methods and cycle-tracking.

Table 4: Descriptive statistics of different groups aged 15–25 receiving birth control pill prescriptions in 2022

	Sample: Public sector with programs	Public sector without programs	Private sector
	(1)	(2)	(3)
Prescription count	5.6	4.7	6.3
Age	20.61	19.55	20.95
Unmarried (%)	97.96	93.03	96.89
Cohabiting w/o children (%)	53.36	29.90	46.97
Born in Finland (%)	93.71	95.48	94.38
Finnish citizen (%)	97.51	98.94	98.39
Finnish speaking (%)	91.46	82.02	90.76
Household size	2.19	2.69	2.09
Lives in city (%)	84.58	53.76	91.26
Lives in countryside (%)	5.98	25.07	3.30
Bachelor's degree or higher (%)	10.11	9.85	9.84
General upper secondary diploma (%)	53.01	44.58	80.57
Employment months in a year	10.08	9.85	9.84
Unemployment months in a year	3.60	3.97	2.86
Disposable income	15 658	13 346	14 888
Earnings	16 510	14 450	15 207
Received student allowance (%)	45.86	38.71	64.17
Debt	21 910	25 184	24 048
Observations	15 452	12 038	14 200

NOTE: Column (1) indicates individuals receiving birth control pills through municipal programs (our estimation sample). Column (2) shows those receiving prescriptions from the public sector but residing in municipalities without a program in 2022. Column (3) covers individuals obtaining prescriptions from the private sector, irrespective of municipal program status.

To offer insight into whether the individuals in our sample receiving birth control pills through free programs differ from those receiving their birth control pills through public or private healthcare,[32] we provide descriptive figures for the three groups in Table 4. The first column describes the individuals in our free program sample. The second column describes individuals receiving public sector prescriptions in municipalities without free programs.

[32]If a municipality does not have a free program in place, an individual may get their birth control pills prescription from either the public or private sector. In any municipality, an individual may choose to get their prescription from the private sector. In this case, they pay for their visit and the pharmaceuticals out-of-pocket.

These are often small and rural. The third column covers individuals receiving prescriptions from the private sector. The table lists means of general individual characteristics related to prescription use, age, marital status, ethnicity, living arrangement, geographic location, education and earnings. The table shows individuals of ages 18–25 in 2022.

In all groups, the average recipient is approximately 20 years old and is likely to be unmarried. The economic indicators are relatively similar for all groups. The table also shows that groups (1) and (3) do not differ much from each other. Those receiving pills from the private sector have a slightly higher prescription count, but in all the count is moderate in all groups. The group in column (2) differs from the other two in several aspects. Over 25 % of those in column (2) live in the countryside, where as the majority of individuals in columns (1) and (3) live in a city. This is explained by the rather wide adoption of programs by 2022: the municipalities that had not adopted programs in 2022 were mostly smaller, rural municipalities with less young women. Additionally, individuals in column (2) live in larger households and have less education.

4.1.2 History dependence

To provide first evidence on history dependence, we show in Table 5 how the probability of choosing the cheapest, mid-priced or the most expensive product in a substitution group after aging out of eligibility for free contraceptives depends on the product obtained in the free program.[33] The rows represent the products received in the free programs, and the columns represent the products bought upon the first visit to the retail pharmacy.

We find that irrespective of the price of the initial product, the probability of buying the same product once the individual needs to pay the price out of pocket is very high, at 80 % or more. For example, 88 % of those receiving the most expensive product in the free program continue to use it after exiting the program. Second, a majority of the individuals obtained a product in the free contraceptives program that will be expensive for them in the retail pharmacy. As a whole, this is suggestive of the firms engaging in the kind of invest-and-harvest behavior that is typical in models with switching costs.

[33]Not all substitution groups have products in the mid-price category, hence its smaller size: for example, a substitution group with three products may have a branded product, which is the most expensive and two parallel imports, that have the same price.

Table 5: Individuals' initial drug used in program and first choice in retail pharmacy within a substitution group

	First product bought in retail pharmacy			Total
Initial product	Cheap	Mid-price	Expensive	
Cheap	4 072 (80%)	81 (2%)	914 (18%)	5 067
Mid-price	64 (7%)	859 (92%)	15 (2%)	938
Expensive	850 (12%)	7 (<1%)	6 026 (88%)	6 883
Total	4 986	947	6 955	12 888

NOTE: The table includes several different substitution groups, where there are at least three separate products. It is conditioned on the individual having a prescription in the free program and a purchase in the retail pharmacy after crossing the age threshold. Individuals that are in the free program and drop out after crossing the age threshold are not included in the table.

4.2 Individuals in the retail pharmacy market

After aging out of programs, individuals must purchase their birth control pills from the retail pharmacies. In this section, we provide similar descriptive statistics about the consumers in the retail market as about those in the programs in Section 4.1.1.

Table 6 shows the descriptive statistics for those using birth control pills and other women in the age group 25–26. In all municipalities, these users are no longer eligible for the free birth control pills. Table 6 compares birth control pill users and other women aged 25–26 across key demographic and socioeconomic characteristics. Pill users are more often unmarried (91 percent vs. 86 percent) and more likely to cohabit without children (62 percent vs. 51 percent), suggesting that they are typically in earlier stages of family formation. They are also more frequently Finnish-born, Finnish-speaking, and citizens, indicating that the use of oral contraception is somewhat more prevalent among native-born women. Household size is smaller among pill users, which aligns with their higher likelihood of living without children. Differences in place of residence are minimal, with both groups predominantly living in urban areas.

Socioeconomic indicators reveal that pill users tend to be slightly better off than their peers. They have somewhat higher educational attainment, are employed for more months during the year, experience less unemployment, and report higher average earnings and disposable income. These differences are modest. Overall, the descriptive statistics imply that oral contraceptive use in this age group is associated with characteristics consistent

with later family formation, higher education, and stronger labor market attachment, but differences between the groups are rather small.

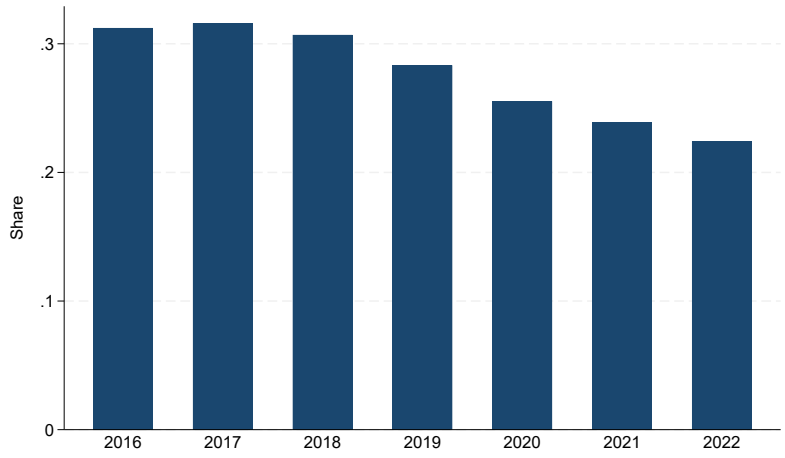
Table 6: Descriptive statistics of birth control pill users and others in age group 25–26 from 2022

	Birth control pill users	Other women
	(1)	(2)
Age	25.48	25.51
Unmarried (%)	91.36	86.05
Cohabiting w/o children (%)	62.22	51.06
Born in Finland (%)	94.05	86.85
Finnish citizen (%)	96.52	90.29
Finnish speaking (%)	89.57	81.46
Household size	1.93	2.10
Lives in a city (%)	85.35	84.99
Lives in the countryside (%)	6.15	6.48
Bachelor's degree of higher (%)	43.58	41.68
General upper secondary diploma (%)	57.09	54.79
Employment months in past year	10.84	10.58
Unemployment months in past year	3.58	4.00
Disposable income	21 908	20 545
Earnings	25 183	22 757
Received student allowance (%)	62.38	61.19
Debt	38 388	38 566
Observations	41 927	260 532

NOTE: Column (1) shows statistics for individuals aged 25–26 who have a birth control pill prescription in the Kanta e-prescription register. Column (2) shows statistics for individuals identified in Statistics Finland's population data. All statistics are calculated based on population data statistics, which prescription data can be merged to.

Figure 6 depicts the share of those in the 25–26 age group with a birth control pill prescription in municipalities with running programs. The share ranges from slightly over 30 % to approximately 23 %. Notably, this post program share of women with prescriptions is higher than the same share among the eligible age group, shown earlier in Figure 5. This is because some of the individuals only get a prescription once they exit the program. Essentially, this ensures us our method of identifying individuals from the data is valid.

The shares of Figure 6 also align with the survey results from Family Federation of Finland (2019), who approximate that 39 % of Finnish women aged 18–34 used birth control pills as their main method of contraception.



NOTE: The Y-axis shows the share of 25–26-year-olds with a public-sector birth control pill prescription among residents of municipalities with programs. Each bar represents the share across all municipalities with a program.

Figure 6: Share of 25-26 year olds with prescription in municipalities with running programs by year

Table 7 presents descriptive statistics comparing the women in our sample with women having prescriptions from the private sector at ages 25–-26. The two groups differ in their marital and living arrangements : women in column (1) are less often unmarried (89 percent vs. 94 percent) and tend to live in slightly larger households. Residence patterns also diverge notably. Women in column (1) are more likely to live outside major urban centers, whereas women in column (2) are concentrated in cities (93 percent vs. 80 percent). These differences suggest that public-sector employment may be more common in smaller municipalities and among women with more established household structures.

Educational attainment and economic indicators further distinguish the two groups. Private-sector pill users are notably more educated, with over half holding a bachelor's degree or higher compared to just over one-third in the public sector. Labor market attachment appears comparable, with nearly identical months of employment and only small differences in unemployment durations. Average earnings and disposable income are

also very similar, though private-sector users earn slightly more. Public-sector users, however, more frequently receive student allowances, consistent with ongoing education or study-related employment. Overall, the descriptive statistics indicates that private-sector pill users are more urban, highly educated, and financially similar to their public-sector counterparts, while public-sector users tend to be more settled, less urban, and somewhat more likely to combine work with study.

Table 7: Descriptive statistics of different groups aged 25–26 with birth control prescriptions in 2022

	Sample: Public sector	Private sector
	(1)	(2)
Age	25.49	25.47
Unmarried (%)	89.22	94.42
Cohabiting w/o children (%)		
Born in Finland (%)	93.00	93.85
Finnish citizen (%)	96.56	96.71
Finnish speaking (%)	89.76	89.48
Household size	2.03	1.73
Lives in a city (%)	80.10	92.86
Lives in the countryside (%)	8.66	2.60
Bachelor's degree of higher (%)	36.25	56.46
General upper secondary diploma (%)	45.55	76.28
Employment months in past year	10.92	10.88
Unemployment months in past year	3.76	2.98
Disposable income	22 283	22 248
Earnings	25 615	26 059
Received student allowance (%)	68.64	56.20
Debt	40 376	39 624
Observations	21 852	11 292

4.3 Pharmaceuticals

Since this paper studies both demand and supply, we next analyze some descriptive statistics regarding the birth control pills and their manufacturers. Descriptive statistics are presented

in Table 8. In the hospital pharmacies, there are 4 ATC5s in the sample and 11 firms operate in the market. Not all firms are present in each ATC5. The firms sell in all 55 different products, which differ from each other in terms of manufacturer, active ingredient and package size. The average size of a substitution group is 2.9 products, and the maximum amount of firms within a substitution group is 4. In all, there is relatively little competition in the substitution group-level markets. From the retail pharmacy side, we include the same 4 ATC5s. There are five firms selling their products to the hospital pharmacies within these ATC5s. The overall number of products is 32.

The mean wholesale package price is 26.15 euros and mean price per DDD is 0.37 euros in the retail pharmacies. When comparing these prices to those in the hospital markets, the difference is striking. The hospital pharmacy products are procured at much lower prices than the wholesale prices in the retail pharmacy: the average package price is 5.45 euros and the average DDD price 0.09 euros. During the sample years many hospital pharmacies used negotiations in addition to the procurements. In these negotiations, they would agree on extremely low prices for products meant to be given to the users the first time. These prices are in the range of some cents per package. For those continuing use, the price would typically be higher, but not as high as the price would be in the retail pharmacy. In the most recent years, which extend out of our sample, hospital pharmacies have started to give up the practice of having separate prices for new and old users.[34]

The average amount of DDDs in a sold package from retail pharmacies is 70.46, reflecting that the majority of the individuals buy packages with 3-months worth of doses at a time. Depending on the active ingredient, three months of worth of doses corresponds to either 63 or 84 pills in a package. The average package size in the hospital pharmacy is slightly larger, 84.21. This reflects the fact that some municipalities hand out 6-month packages to free program users.

[34] Anecdotal evidence suggests the main reason for this is practicality. When a given product has several prices, the IT systems in the hospital pharmacies have trouble with it. There have also been issues with the healthcare providers purchasing products meant for new users for old users at a lower cost.

Table 8: Descriptive statistics for retail and hospital pharmacy products from 2022

	Retail pharmacies	Hospital pharmacies
ATC5 count	4	4
Substitution group count	10	
Product count	55	32
Firm count	11	5
Mean package price (euros)	26.15	5.45
Mean DDD price	0.37	0.09
Mean DDD amount	70.46	88.98
Sales in euros	4 677 464	3 172 847
Sales in packages	178 859	250 391
Sales in DDD	12 602 793	20 425 293

NOTE: Prices are presented in nominal terms. Hospital pharmacies do not have substitution groups. Substitution groups are used in retail pharmacies to distinguish which products are substitutable through generic substitution.

In the retail pharmacies, the sales are slightly over 4.6 million euros, with close to 180 000 packages sold. Sales in DDDs reach 12.6 million doses. The figures for the hospital pharmacies reflect the lower average prices. The number of packages and DDDs sold exceed those of the retail pharmacies, yet sales in euros are lower.

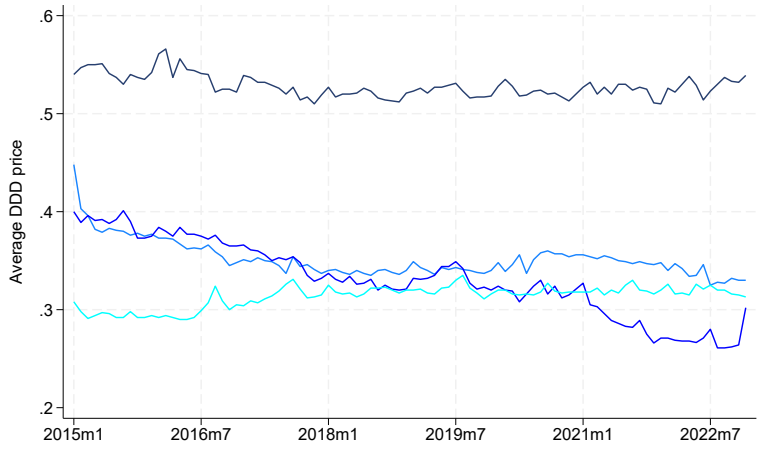
Table 9: Market shares of different types of retail pharmacy products from 2022

	Retail		Hospital	
	In DDDs	In euros	In DDDs	In euros
Branded	0.32	0.39	0.89	0.92
Generic	0.42	0.34	0.11	0.08
Parallel	0.26	0.27	0	0

NOTE: Shares are calculated from the markets in 2022.

Table 9 depicts the market shares of different types of products in the retail pharmacy market, calculated using DDDs on one hand and in monetary terms on the other hand. In the hospital pharmacy, nearly 100 % of the products sold are branded products. The market shares in the retail pharmacy are divided somewhat evenly between the different types of drugs present in the market: branded, generic and parallel imports. When measured in DDDs, the generics hold the largest market share. The market share figures have been

calculated on the ATC5-level. When measured in sales in monetary terms, branded drugs hold the largest share. An interesting feature of the Finnish birth control pill market is the amount of parallel imports and their relatively large market share. In general, parallel importing is not a common phenomenon in Finland: only approximately 3 % of all sold drugs were parallel imports between 2016–2020 (Copenhagen Economics, 2021). In the birth control pill markets, parallel imports are present in all of the substitution groups at some point in time. In 2025, every substitution group has a parallel-imported drug (Fimea, 2025c). Their influence can be seen clearly in the average market share measured both in DDDs and euros, as they represent over a quarter of all sales. In the hospital pharmacy markets, parallel imports are generally not present.



NOTE: Each line represents an ATC5, not a substitution group. The prices used in the analysis are nominal prices charged from the individuals at the pharmacy.

Figure 7: Mean retail pharmacy DDD prices of 4 sample ATC5s between 2015–2022

Finally, figure 7 shows the average DDD prices of each ATC5 in the retail pharmacies stay relatively constant over time. Measuring prices in DDDs allows us to look at the price per dose and compare and aggregate prices over for example different package sizes.[35] There have not been patent expirations in the ATC5s in our sample during or closely prior to the sample period. Entry and exit are also relatively uncommon, and are mostly restricted to

[35]This type of comparison is not as straightforward in all active ingredients or broader ATC classes, as in some cases the same active ingredient can be offered in multiple strengths and have to be used accordingly. All the birth control pills in the sample have a daily dose of one pill. This means that the number of pills in the package will automatically correspond to the amount of DDDs in a package.

parallel-imported products.

When assessing demand, one should also take into consideration the availability of products. By availability, we refer to whether all alternatives in the potential choice set, i.e. the substitution group, are also available for purchase in the retail pharmacy. The availability can be affected through drug shortages. There are some reported shortages in our sample substitution groups, but based on our analysis, we conclude that pharmacies have not been out of stock of the products in our sample for extended periods. For more information on shortages and how we are able to identify them, refer to Appendix C.

5 Reduced form analysis of history dependence

We observe individuals i making repeated purchase decisions in periods t. Choices in each period are indicated by j and the analysis is done on the dispensing level. One observation is therefore a dispensed prescription, that has originally been given to the individual in the free program. We begin with a reduced form analysis to analyze the choices of the consumers and evaluate whether there is path dependence associated with their purchasing behavior.

Following Janssen (2023), we model the choice of consumer i within substitution group s in period t as

$$Y_{ist} = \alpha + \beta_1 D_{is0} + \beta_2 \text{Nurse}_i + \beta_3 D_{is0} \times \text{Nurse}_i + \lambda X_{it} + \delta_{st} + \epsilon_{ist}, \tag{1}$$

where the outcome Y_{ist} takes value 1 if individual i declines substitution to the cheapest option in the substitution group in period t. We identify this by observing which product they were prescribed and the product they purchase as well as the prices of these alternatives. In the case of the individual having been prescribed something other than the cheapest product, by declining substitution she will be foregoing the chance to switch to a cheaper alternative, as it should by law be offered by the pharmacist upon purchase. Purchases should be viewed as purchase occasions, so t is not measured in months.

True history dependence is captured by the dummy D_{is0} indicating whether the product

purchased in t is the same as the initial product prescribed in the free program at $t = 0$. In our setting, the initial choice is plausibly exogenous and most likely also uncorrelated with unobserved heterogeneity, both conditions that are econometrics-wise required to make the setting work.

Nurse_i is a dummy that takes value 1 if the person has a qualification to be a nurse, practical nurse or paramedic. Janssen (2023) uses a similar dummy to a indicate whether the patient is a physician. The individuals in our sample are very young, so there are no doctors in the sample, which is why we use this definition. Naturally, compared to physicians that are actively prescribing products in their work, knowledge of the prescription and reimbursement system is more debatable in the case of nurses, practical nurses and paramedics. We also run a different specification, where the nurse dummy is replaced with a dummy that takes value 1 if the person has within the past year had an above average amount of prescriptions (of any drug) that have been dispensed. The average in the sample is approximately five prescriptions. The intuition is that these individuals should be especially familiar with the process of generic substitution and the costs associated with declining a substitutable, cheaper alternative. These results are shown in Figure 19 of Appendix D. The interaction between Nurse_i and D_{is0} should be insignificant if it is the case that state dependence is induced by past purchase behavior rather than perceived differences in quality. In Equation 1, the switching costs are identified by β_1 and perceived taste differences by β_2.

X_{it} include individual-level controls like the highest education level obtained and logarithm of disposable income. There are no pharmacy chains in Finland, but that does not rule out the possibility for regional differences across pharmacies. We therefore also control for the geographical location of the pharmacy. The δ_{st} includes substitution group-level fixed effects in each time period. The variation captured by the model is therefore between individuals who purchase a product within a given month.

The described model should give us an intuition of whether there is inertia in the oral contraceptives market, which was already strongly suggested by our descriptive statistics in Section 4. It does, however, absorb out some factors that may affect individuals' purchase behavior or tastes, among which price differences are perhaps the most important one.

Table 10 shows the evidence from estimating Equation 1. The table indicates that a having obtained the same product j for free in the program increases the probability of opposing substitution significantly by 38.2 percentage points in the case of oral contraceptives. The degree of path dependence suggested by these results is aligned with what we observe in the descriptive statistics. Individuals tend to stick to the same product, when not accounting for price differences.

Table 10: Reduced form evidence on probability of opposing substitution

	Opposed substitution
D_{is0}	0.382
	(0.058)
Nurse_i	-0.027
	(0.015)
Education	-0.036
	(0.032)
$\text{Nurse}_i \times D_{is0}$	-0.092
	(0.058)
Income	Yes
Geographic FE	Yes
Substitution group FE	Yes
Observations	37 532
R^2	0.54

The magnitude of path dependence is rather high in comparison to some earlier literature such as Janssen (2023). He documents only 1-3 percentage point increases in a similar setting, the difference to our analysis being he studies painkillers and antibiotics. With anti-epileptics, that are often used long-term, he finds negative switching costs and hypothesizes it may be due to patient learning. According to the medical literature, in general switching between hormonal methods of contraception is rare (Steinberg et al., 2021). The human hormone system is known to be extremely sensitive. Even though the drugs are exact substitutes, there may be some types of beliefs related to hormone-affecting drugs. The propensity of switching oral contraceptives could be lower than that for other drugs because

of the type of the drug.

The results also suggest being a nurse, practical nurse or paramedic user decreases the probability to oppose substitution by 2.7 percentage points. The interaction is not statistically significant, hinting that having many prescriptions and dispensing them is not associated with switching costs. It also supports the argument that unobserved heterogeneity and switching costs do not seem to be correlated. Having more education[36] slightly decreases the probability of opposing substitution, but the coefficient is not statistically significant.

The reduced form analysis in combination with the evidence from the descriptive statistics suggest the presence of strong history dependence and switching costs. These analyses, however, neglect the effects of price differences. Price differentials are an important part of drug purchase behavior, and it could be argued especially so in the case of birth control. The products are in general not reimbursable and therefore not price regulated. Modeling the phenomenon structurally allows us to estimate demand and further understand the effects of history dependence on pricing dynamics when modeling the supply stage. Furthermore, the structural model of demand and supply allows us to construct policy-relevant counterfactuals.

6 Structural model

6.1 Demand

We estimate a discrete choice mixed logit model accounting for price endogeneity and incorporating the random initial choice to disentangle history dependence from unobserved heterogeneity. We again use moving from enrollment in the free program to the pharmacy-administered use of contraceptives and making repeated purchases to identify history dependence. Going over the age limit of the free of charge program can be perceived as an exogenous shock, that forces the consumer to make an active decision on their choice of contraceptive. The main objective of the demand model is to understand

[36]The variable is originally a 6-tier classification with the lowest tier being comprehensive school degree and the highest degree being a doctoral degree.

whether using a given product for free will through history dependence affect later demand of individuals, given that they may also be sensitive to prices. We find that this is indeed the case of birth control pills. After estimating the model with the free program sample that allows us to recover the true state dependence parameter, we estimate the same equation for the entire population of birth control pill users, imposing the previously obtained history dependence coefficient on them. In this section, we describe the model from the viewpoint of the free program sample.

In the demand model, the utility of a consumer i from purchasing product j in a substitution group s at time t is

$$u_{ijst} = \alpha_{is} p_{jst} + \gamma_{is} D_{ijs0} + \xi_{ijs} + \varepsilon_{ijst}. \tag{2}$$

We construct the choice sets of the consumers in each period by observing which products have been on the market in a given month. The sizes of the choice sets vary between 2–5 products. Choice sets may change over time as products exit and enter. The variable p_{jst} is the pharmacy retail price of product j at time t.[37] The term ξ_{ijs} denotes the unobservable heterogeneity of individuals and products. ε_{ijst} is the error term that is iid and follows the type-I extreme value distributions: it is the individuals idiosyncratic preference shock for product j in substitution group s at time t. γ_{is} is the coefficient of interest and indicative of the switching costs, as D_{ijs0} is a dummy taking value 1 when the individual has purchased the same product j at time t as they received in the free program at $t = 0$. By the same product, we refer to a product from the same brand and the same manufacturer, so we do not differentiate between package sizes. This is due to the fact that a person with an oral contraceptive prescription may purchase any package size they want of a drug with given strength. In the current specification, we do not have an outside option, because nearly all of the prescriptions of sample individuals are also dispensed.

The problem of identifying the switching costs from unobserved heterogeneity is two-fold. Firstly, a clean identification is helped by an exogenous initial choice. Solutions to this problem include using patent expiries and generic entry (Feng, 2022) or making

[37] The retail price consists of the wholesale price, pharmacy markup (described in Table 1) and value-added tax (VAT).

informational assumptions of consumers making their initial choice and defining markets narrowly enough to ensure almost complete homogeneity of products (Janssen, 2023). We rely on our institutional setting to provide a very clean and plausibly exogenous initial choice. Secondly, the drug purchase behavior may not only be affected by purchase history, but also unobservable individual characteristics: essentially one could be worried that repeated purchases would be due to personal characteristics instead of switching costs. When studying pharmaceutical demand, the unobserved heterogeneity can be interpreted as a sort of unobserved match quality to a product. In our institutional setting, these match qualities are unlikely to exist: products are very often exactly the same as many substitution groups consists of only the branded drug and its parallel imports.

Additionally, we need to account for price endogeneity, because it may be that prices are correlated with certain unobservable product characteristics. For tackling the price endogeneity, we follow the approach of Janssen (2023) and use a control function of the form

$$p_{jst} = \beta Z_{jst} + \rho_j + \mu_t + \kappa_{jst}, \tag{3}$$

where Z_{jst} are Hausman-like instruments. We use the prices of the same products in Denmark and Sweden. These products should essentially have quite strongly correlated prices, as cost factors such as the supply chain, transport costs and ingredient costs are correlated, but demand is not. True Hausman-instruments would require exact product matches to exist in the neighboring countries, but with pharmaceuticals this is seldom the case. Instead, we follow the example of Markkanen (2024) and use a hedonic regression to impute the prices of products that are not found in Sweden and Denmark. The method is described more thoroughly in Appendix E. ρ_j includes the product fixed effects. μ_t are the time fixed effects in calendar months. The error term is uncorrelated with Z_{jst}: prescriptions allow purchases from within a given substitution group and demand effects between them should not exist.

Modifying Equation 2 to account for price endogeneity and unobserved heterogeneity,

we arrive at

$$u_{ijst} = \alpha_{is} p_{jst} + \gamma_{is} D_{ijs0} + \lambda \hat{\kappa}_{jst} + \epsilon_{ijst}. \tag{4}$$

The idiosyncratic error term from the control function enters the estimation equation. $\hat{\kappa}_{jst} + \epsilon_{ijst}$ represent the ε_{ijst} term in Specification 2. We estimate Equation 4 using the sample consisting of the first purchases in the retail pharmacy sector upon having left the free contraception program.

Once we have estimated the first demand model and uncovered the true history dependence, we estimate the following for the entire population of birth control pill users:

$$u_{ijst} = \alpha_{is} p_{jst} + \hat{\gamma}_{is} D_{ijs_{t-1}} + \lambda \hat{\kappa}_{jst} + \epsilon_{ijst}. \tag{5}$$

In this specification individuals make repeated purchase decisions. $\hat{\gamma}$ is the parameter from Specification 4 and $D_{ijs_{t-1}}$ is the dummy that takes value 1 if the individual has purchased the same product at the previous purchase occasion. Time t is measured in purchase occasions. Consumers making choices appear in the data in varying intervals. Some purchase a product each month, meaning they buy doses for every month separately, whereas most buy larger packs at a time and thus appear in the data fewer times. We include purchases up to one year after the first purchase.[38] Thus a consumer can have at maximum 12 choice observations in the data. On average we observe approximately 4 purchases within the year.

In both specifications, we assume that consumers are myopic: consumers do not form expectations of future prices, and estimates of for example switching costs will not be dependent on those beliefs. This assumption is standard in the literature as it significantly simplifies modeling and allows us to use a traditional static demand model. This is supported by the fact that the nature of the drug does not allow for pauses in use or delay of purchase, hence individuals make their purchase decisions based on only on current prices. In addition, individuals are not able to stockpile: regulation prevents pharmacies from dispensing the entire prescription at once and prescriptions have a designated, fixed

[38] This is done because prescriptions are typically valid for one year. Although renewing a prescription should not incur costs in the public sector, it may be a natural point at which to for example switch methods.

quantity to them. Most individuals in the sample buy a single package at a time and purchase the next package close to when the previous package's indicated dosage is running out.

Our institutional setting allows us to identify true state dependence. In the case of true state dependence, the initial product is distributed randomly and further choices are not affected by outside factors. In the case of spurious state dependence, the administering of the initial product would not be random, but rather affected by characteristics or preferences of the prescriber or matched to the qualities of the individual. We argue that the former holds in the case in question and estimates presented in this paper of history dependence should be perceived as true state dependence.

The case of spurious dependence could arise, if doctors had a large choice set initially, but as the choice set of the physician is strongly limited by the selection of products available at their hospital procured by the regional hospital pharmacy, the role of the physician is less important in our setting. Furthermore, the individuals are not distributed to the physicians based on any individual preferences. In most cases, the individuals will book an appointment at the clinic without knowing who their physician or nurse will be. The physician could also affect the choice in the pre- and post-periods, if the individuals would have to visit the same doctor again after they are no longer eligible for the free contraception. This does not happen, as individuals are left with a prescription after they exit the program and often do not interact with the prescriber before entering the retail pharmacy market as a consumer. We believe this alleviates the concern for physician-induced spurious state dependence. We also observe the identity of the prescribing physician or nurse and are thus able to control for prescriber-specific fixed effects in our data if need be in the future.

In the second case spurious state dependence could arise if individuals were matched to the initial products based on their characteristics. In the case of pharmaceuticals, it is almost certain this happens to some extent: in general physicians or nurses should not prescribe products that are not suited for the individuals. However, as we operate on the substitution group level where drugs are identical to each other, this should not be a concern. The characteristics of the individual will surely affect the chosen method of contraception (pill, capsule, IUD, ring etc.) as well as the active ingredient: For example,

an individual with aural migraines would generally not be prescribed a combination pill of ethinyl estradiol or drospirenone, but perhaps a progestin-based contraceptive. Within the active ingredient and especially within a substitution group, it is unlikely this will be of concern. Any pill should by observable characteristics be suitable for the individual and their characteristics should not affect the choices within substitution groups, alleviating concerns of spurious state dependence. Our data includes all the other prescriptions of individuals, in addition to which we have access to sick-leave benefit data, that could be used to include individual health characteristics if needed.

6.2 Supply

The supply side resembles that of a standard IO application, where we assume firms compete Bertrand-Nash and are myopic, such that the model is static.[39] As our sample only includes substitution groups that are not price regulated, we need not consider the implications of maximum wholesale price regulation in our supply-side modeling: the optimal pricing strategy alone allows us to identify the marginal costs.[40]

Denoting the per-period profits π_{ft} of a firm f selling all of its products in the set F in a market that is defined by month t and substitution group[41] s, the profit maximizing condition is given by

$$\pi_{ft} = \sum_{j \in F_f} [p_{jt} - c_{jt}] m_{jt} Q_t, \tag{6}$$

where for firm f in period t p_{jt} is price, c_{jt} is marginal cost, m_{jt} is the market share of a given firm at a given time and Q_t is market size of the substitution group. The market size corresponds to the purchases observed, $m_{jt}Q_t$ can be interpreted as the quantity demanded q_{jt}. Although this notation allows for multiproduct firms, in the usual case a firm will only have one product in a given market. The expressions thus reduce to

$$\pi_{jt} = [p_{jt} - c_{jt}] m_{jt} Q_t. \tag{7}$$

[39] We are currently working on extending the supply side to a dynamic model.
[40] An example of a price-constrained equilibrium is provided by Dubois and Lasio (2018).
[41] For simplicity, we leave the subscript s out of the following equations.

We consider the firms profit-maximizing conditions in prices, assuming they are competing á la Bertrand-Nash. If a pure strategy equilibrium exists, price of a given product from firm j at time t should satisfy the first-order condition

$$q_{jt} + \sum_{k \in F_f} (p_{kt} - c_{kt}) \frac{\partial q_{kt}}{\partial p_{jt}} = 0. \tag{8}$$

In matrix form, this can be written as

$$D_f(\mathbf{p}_t - \mathbf{c}_t) = -[D_f Q_{p_t} D_f]^{-1} D_f \mathbf{q}_t, \tag{9}$$

where D_f is the $J \times J$ diagonal matrix with row elements $\mathbf{1}_{j \in F_f} = 1$ if $j \in F_f$. Q_{p_t} is the $J \times J$ matrix with in row i and column j elements being elasticities $\partial q_{jt} / \partial p_{it}$. Vectors $\mathbf{q}_t$ and $\mathbf{c}_t$ denote quantities and marginal costs of products J at time t.

Combining the assumption of conduct with the demand estimates as well as observed prices, we are able to calculate the marginal costs by solving the system of first-order conditions presented above. The conduct assumption entails firms are setting prices simultaneously and taking prices of others as given. Furthermore, we need to assume there is no collusion, no vertical contracting or no dynamics in the pricing strategies. It should be noted that this assumption is not violated even with the so-called dynamics of the hospital and retail pharmacy stages. We do not have reason to believe firms are acting collusively in the retail pharmacy stage, but any discrepancy in prices of a given product in the hospital and retail pharmacy sector is rather a result of the history dependence in the demand.

Marginal costs are allowed to vary in time, as pharmaceuticals are subject to regulatory and supply shocks. Alternative methods also exist: Dubois and Lasio (2018) mention using long-term price equilibria to determine marginal costs, assuming the price-cost margins of drugs are close to zero. Grabowski and Vernon (1992) use this approach and argue the marginal cost of a molecule is close to the price of the generic in the market with the lowest price. This would likely require a heavily competitive market, which the birth control pill markets are not. A time-varying marginal cost provides estimation flexibility: variation in

the observed prices does not stem solely from demand shocks, so allowing the cost to vary gives flexibility to rationalize observed price changes.

Finally, we note that currently we are using wholesale prices in the specification instead of retail prices. When using retail prices, we would need to explicitly model the retail pharmacy markup as well as the value-added tax. We are currently working on this extension.

7 Results

7.1 Demand

We estimate the demand side with Equation 4 with the sample of 42 344 individuals making purchase decisions for the first time in the retail pharmacy. Table 11 presents the results from a mixed logit specification with and without a control function for the prices.

The first stage results indicates the prices of oral contraceptives in the foreign markets have a strong impact on the prices of the Finnish oral contraceptives. The results of the demand model are for Equation 4. Model 1 excludes the price control functions, but includes the original product term. The specification of Model 2 includes the both the control function to tackle price endogeneity and the original product term to distinguish path dependence from unobserved heterogeneity. The random coefficients are for the price and state dependence variables and are assumed to be normally distributed.

The main results of Table 11 concern price sensitivity and history dependence. Firstly, the price coefficients are negative and statistically significant. In this context, it is not a given that the price parameters will or should behave in such a way. We observe a large share of individuals purchasing more expensive products even when cheaper alternatives are available. In principal, this could lead to a positive or close to zero price coefficient. We take the coefficient as an indication of slight price sensitivity. Secondly, the history dependence coefficient reveals individuals are far more likely to purchase a given product if they have also done so in their previous visit to the pharmacy. The result or the magnitude of the coefficient is perhaps not surprising, if one takes into account the descriptive statistics of Section 4.1 and results from the reduced form analysis in Section 5.

We can use the coefficients to understand the willingness to pay for a so-called favored products in the style of Janssen (2023). On average individuals are willing to pay[42] roughly two euros more for a product if they have used it before. The figure is in the range of the actual price differences within substitution groups and corresponds to roughly 8 % of the average price of a package.[43] This is slightly higher than what Janssen (2023) finds, which is that patients are willing to pay on average 2–3 % more for drugs they have used before.

Table 11: Demand model results for sample of free program users

	First stage	Model 1	Model 2
Foreign prices	0.176		
	(0.010)		
Package price mean		-0.452	-0.779
		(0.022)	(0.085)
SD		0.021	0.495
		(0.065)	(0.073)
History dependence mean		0.429	0.344
		(0.022)	(0.024)
SD		0.104	0.253
		(0.062)	(0.051)
Control function			-0.142
			(0.043)
Control function		No	Yes
Log-likelihood		-5581.19	-4010.92
Calendar-month FE	Yes		
ATC5 FE	Yes		
F-test	1019.96		
N	24 549	30 382	29 817

The average own price elasticity is -1.49 (SD 1.18) and the average cross-price elasticities are 1.29 (SD 1.4). Table 20 in Appendix F shows the average price elasticities for a panel of five substitution groups.

[42]The willingness to pay is calculated by dividing the history dependence coefficient with the negative of the price coefficient.

[43]The mean package price of retail pharmacy packages is 26.15 euros.

Having uncovered the true state dependence parameter, we can estimate Equation 5 the whole population of individuals using birth control pills and imposing the estimated history dependence parameter from Table 11 on it. The results of this are presented in Table 12. Model 1 does not include the imposed history dependence parameter $\hat{\gamma}$. Model 2 includes it. Both models include the control function.

The first stage regression confirms the relevance of foreign prices: the coefficient is positive and statistically significant. In the demand models, we observe that the mean package price negatively affects demand, with the effect being substantially larger in Model 2, which accounts for state dependence. This indicates that past usage reinforces current demand. The standard deviation of package prices is high in both models, reflecting heterogeneity in price sensitivity across individuals. The control function is negative and significant in both models, suggesting the importance of correcting for endogeneity of prices.

When history dependence is included in Model (2), the estimated price coefficient becomes substantially larger in absolute value. This occurs because, in the presence of state dependence, part of what initially appeared as a muted price effect is in a sense absorbed by past usage. Without controlling for past behavior, the model attributes some of the persistence in demand to price insensitivity rather than history dependence.

Once we account for true state dependence, the model separates these two effects: the persistence due to past usage is captured by the history dependence parameter, leaving the price coefficient to reflect the "pure" marginal effect of price on demand. As a result, the estimated price elasticity grows in magnitude, reflecting a stronger immediate response of individuals to price changes when the persistence of past behavior is accounted for.

In other words, ignoring state dependence tends to understate the true price responsiveness because the model conflates behavioral inertia with low sensitivity to price. Including history dependence corrects for this, revealing that individuals are actually more responsive to price changes than suggested by a model ignoring past behavior. The results confirm the presence of significant state dependence in birth control pill usage and underscore the value of imposing the estimated history dependence parameter when scaling the model to the full population.

Table 12: Demand model results for the population of birth control pill starters

	First stage	Model 1	Model 2
Foreign prices	.071		
	(.001)		
Package price mean		-.034	-.150
		(.007)	(.007)
SD		.769	.673
		(.008)	(.007)
Control function		-.252	-.237
		(.007)	(.006)
History dependence		No	Yes
Control function		Yes	Yes
Log-likelihood		-128 712.59	-121 530.81
Calendar-month FE	Yes		
ATC5 FE	Yes		
F-test	18 255.14		
N	495 997	429 380	429 193

We also calculate the elasticities for this sample. The average own elasticity is -2.15 (SD 1.13) and the average cross elasticity is 1.79 (SD 1.55).[44] Table 13 shows the average price elasticities for a panel of five substitution groups. In each panel table, there is a branded product and its competitors. Competitors may be either generic products or parallel imports.[45] The elasticities in Table 13 display a pattern, where the own price elasticity of a branded drug is typically smaller in absolute value than those of competitors. This is not unexpected, given our descriptive results that indicated individuals display history dependent behavior especially when they have been originally administered branded products. At the same time branded products are the most expensive alternatives in all substitution groups in the sample, meaning individuals will pay more out-of-pocket.

[44] A study by Gugler and Szücs (2023) estimates a similar elasticity of -1.98 for the ATC1 class G.

[45] Notions of which group the products belong to are hindered so that substitution groups are not recognizable.

Table 13: Average price elasticities for a sample of substitution groups

(a)

	Branded drug	Competitor #1	Competitor #2
Branded drug	-1.595	.576	.872
Competitor #1	.569	-2.398	2.923
Competitor #2	.722	2.846	-2.216

(b)

	Branded drug	Competitor #1	Competitor #2
Branded drug	-.325	.162	.075
Competitor #1	.427	-5.598	5.250
Competitor #2	.299	5.432	-5.587

(c)

	Branded drug	Competitor #1	Competitor #2
Branded drug	-.223	.104	.103
Competitor #1	.260	-3.164	2.920
Competitor #2	.178	3.139	-3.301

(d)

	Branded drug	Competitor #1	Competitor #2
Branded drug	-.303	.140	.031
Competitor #1	.488	-4.047	3.496
Competitor #2	.231	3.072	-3.100

(e)

	Branded drug	Competitor #1	Competitor #2
Branded drug	-2.126	.847	1.168
Competitor #1	.360	-2.144	1.785
Competitor #2	.882	1.837	-2.589

NOTE: In each panel table, a cell gives the percentage change in market share of the row product when the price of the column product changes by one percent. Competitors may be either generic products or parallel imports.

Table 13 illustrates the differences in own elasticities of branded drugs and the competitors. In all substitution groups, branded drugs have elasticities that are in absolute values smaller than their competitors. The cross elasticities also provide an intuition of the substitutability of the drugs in the eyes of the consumers. Competitors, which are either generics or parallel imports, have higher cross elasticities with each other than with the branded drug. This means that even if the branded drug becomes more expensive, the effect on the demand of the competitors will be relatively small. These difference are especially pronounced in panels (b), (c) and (d).

7.2 Supply

In the supply stage, we back out marginal costs with the assumption that firms are competing Bertrand-Nash. Figure 8 shows the distribution of the marginal costs and Table 14 shows the average marginal costs per product type. The average marginal cost is approximately 5.85 euros, which corresponds to about 22 % of the average package price. This is aligned with earlier findings in the literature: Janssen (2023) estimates marginal costs to be approximately 22 % of prices, Dubois and Lasio (2018) document margins of 9–37 % for branded drugs and 23–47 % for generics. The US Council of Economic Advisers (2018) refers to a 16 % margin their report. Pharmaceuticals are typically seen to have have low marginal costs and relatively large markups. In our data, markups range from 27 to 80 % in the retail pharmacy market, with the average being 70 %.

Table 14: Average marginal costs per product type

	Average marginal cost in euros
Branded	5.91
Generic	4.84
Parallel import	3.65
Net	5.22

Although marginal costs are estimated from retail pharmacy drugs and their demand, we do not have any reason to believe the products sold in the retail pharmacy differ from

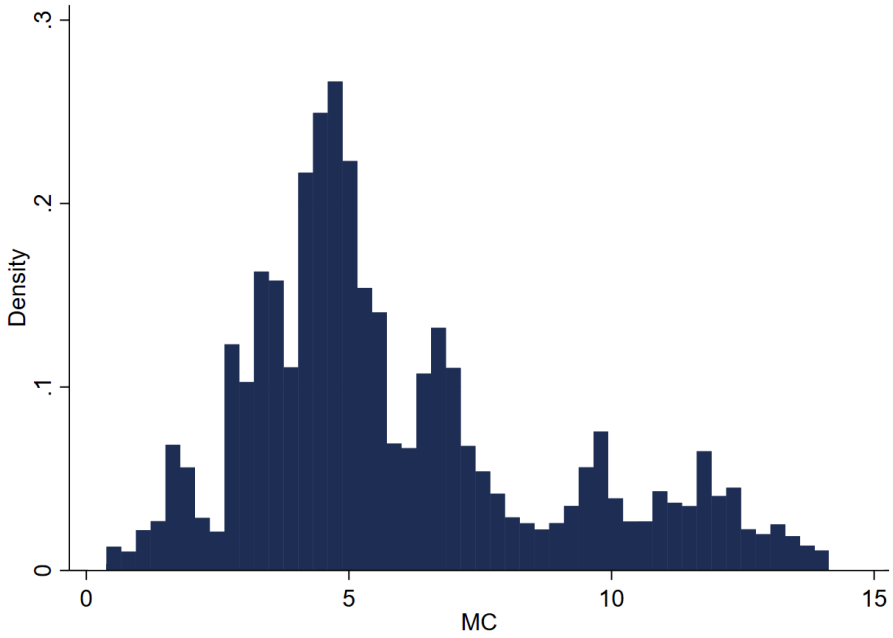


Figure 8: Marginal cost distribution

the same products distributed through the hospital sector. The calculated marginal cost estimates thus apply for the products in both retail and hospital pharmacies. As one can recall from Table 8, the average package price in the hospital pharmacy was approximately 5.5 euros. Referring to Table 14, we notice a substantial share of products are being sold to the hospital pharmacies below their marginal cost.

Selling below marginal cost essentially means foregoing profits in the hospital pharmacy stage. When firms are allowed to price freely in the retail pharmacy stage, they can recover the rents through higher prices. This motivates our first counterfactual, where we remove path dependence and see how firms would price in this situation.

The prices used in the supply-side are wholesale prices and thus differ slightly from prices used in the demand side estimations. This is due to the fact that Finnish retail pharmacy prices are calculated using a tiered formula for different wholesale price levels. The formula includes a multiplier and the pharmacy margin. There have also been changes to these formulas over time. Further information on the pricing formulas and the system can be found in Table 16 in Appendix A.2.

7.3 Counterfactuals

We provide three counterfactuals that provide insights into firm incentives and consumer utility. Some of them represent alternative policies. In the first counterfactual, we turn off history dependence. In the second counterfactual, we abolish the hospital pharmacy market and move all demand to retail pharmacies. In the third counterfactual, we implement a very simple reimbursement schedule offering reimbursement for all individuals purchasing pharmaceuticals in the retail pharmacy.

Counterfactual #1

In the first counterfactual, we set the history dependence parameter to zero and re-estimate the prices of the products. This would correspond to a situation where consumers would truly consider all products in a substitution group perfect substitutes, and there would be no demand or informational frictions – an objective that is difficult to achieve through some given policy. Rather, the counterfactual is illustrative of how large rents the firms are able to collect from the retail pharmacy because of history dependence.

In the counterfactual, we simulate a scenario in which the history dependence is removed. In the original demand model, one of the random coefficients captured the effect of past choices on current choice probabilities, reflecting habit or loyalty. To construct the counterfactual, we set this coefficient to zero for all individuals, effectively eliminating the influence of prior choices on utility. Using the modified parameters, we recompute individual choice probabilities for each product, holding all other estimated coefficients and characteristics constant. These probabilities are then aggregated to the market level to obtain expected market shares without history dependence. Finally, these market shares are used to compute counterfactual prices and profits under the assumption that firms adjust their prices to maximize profits given the new demand. This procedure isolates the impact of past purchases on both consumer choices and firm outcomes.

Table 15: Effects of removing history dependence on average prices

	Observed average price	Counterfactual price	Percentage change
Branded	28.05	23.48	-16.3
Generic	25.56	23.45	-8.3
Parallel	25.55	22.79	-10.8

As shown in Table 15, removing history dependence from the model decreases the prices on average by 13 %. Prices decrease for branded, generic and parallel-imported products, but the largest decrease is for the branded products. Counterfactual prices are below the observed prices in the data for all product types. The gap between the prices of branded and generic products decreases slightly in absolute terms, whereas the difference between branded and parallel-imported products increases. It should, however, be noted that there are more parallel imports than generics in the market and not all markets have generics present in each period.

It should be noted that removing history dependence in this counterfactual exercise will effectively remove both the history dependence resulting from the programs as well as the history dependence that may accumulate naturally. As said, state dependence in demand has been widely documented in pharmaceutical markets (Ching, 2010; Feng, 2022; Granlund, 2021; Ito et al., 2020; Janssen, 2023; Janssen & Granlund, 2023) and it does not only happen in a situation where an individual receives drugs for free initially. Some of it builds over time due to different reasons including tangible and intangible switching costs, inattention and even learning. This counterfactual thus provides an upper bound for effects instead of defining absolute values for them.

For firms, decreases in prices indicate changes in profits from the retail pharmacy sector. Figure 9 portrays the average percentage changes in prices, market shares and profits of firms. It should be noted that even the firms that do not supply to the hospital sector may enjoy the benefits of history dependence: if a consumer happens to switch to their product at some point, they are also more likely to continue using that product. This means that changes are expected in both the prices and market shares of all types of firms, even those, namely parallel imports, that do not supply to hospital pharmacies.

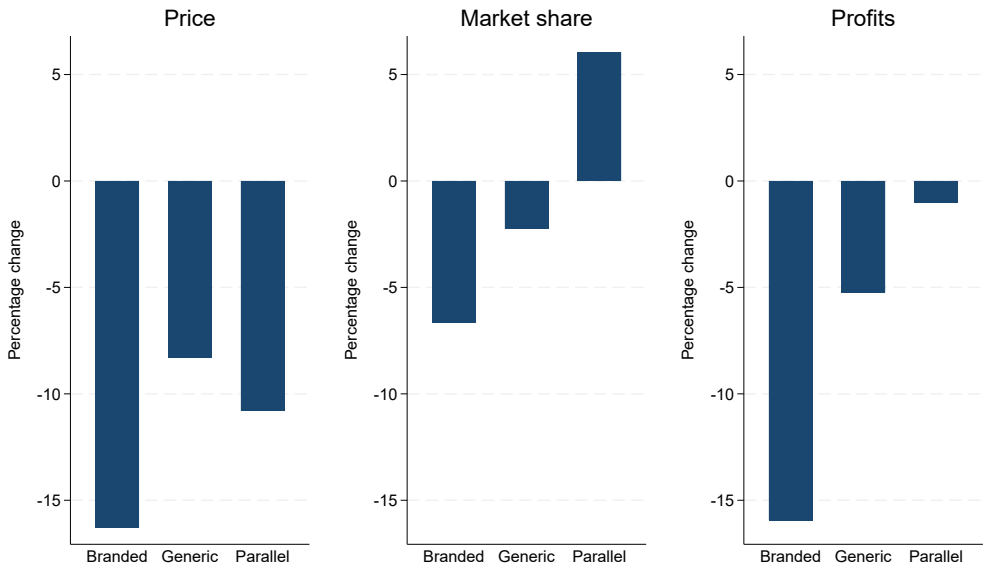


Figure 9: Percentage point changes in average prices, market shares and profits over brand types in counterfactual scenario in comparison to baseline

The natural unit of assessing utility changes inflicted on the consumers is in monetary terms. For the consumers, decreases in prices of pharmaceuticals means explicitly less out-of-pocket costs in the retail pharmacy stage. In the first counterfactual exercise, individuals pay on average 7.3 euros less for each pill package and 43.7 euros less over the course of one year.

Indeed, the prices, market shares and the profits of the branded products and their firms decrease the most. Parallel imports face least harm from removing history dependence: their prices decrease accordingly, but market share grows and profits remain almost unchanged. Generic products, which present a minority in the substitution groups, face similar effects as branded products, although smaller in magnitude.

Finally, we can assess the firms' incentives to participate in the hospital pharmacy procurements and offer products with significant discounts. We naturally assume firms are not willing to operate at a loss: removing the history dependence will result in smaller profits, because firms, especially those selling branded products, are no longer able to hold on the locked-in customer base they have created in the free programs. Using the marginal costs obtained from the demand and supply models along with the prices of products in the

hospital sector, we can calculate what the average cost of investing in the hospital market is and what the average profits gained in the retail pharmacy markets are. On average, firms invest 0.12 million euros into the hospital market and are able to gain 0.57 million euros in the retail pharmacy market.

Counterfactual #2

In the second counterfactual, we abolish the free programs and thus the hospital pharmacy sector, moving all demand to the retail pharmacies. This counterfactual is especially interesting from the viewpoint of the consumers: it gives an insight into what the monetary benefits of the programs are for birth control pill users.

In the counterfactual, we concentrate on individuals that we are able to observe enrolling and exiting the program. We assume that they would have started using birth control at the time they actually started, even if there no free contraceptive programs available. In this sense, we are possibly overestimating the savings.

For those that we are able to reliably observe their full time in the programs[46], the average spell is 3.6 years. The monetary benefit of the baseline (i.e. programs are in place) and the counterfactual (i.e. no programs) is on average -422 euros. In the baseline the savings an individual generates from being in a program and one year of post-program pill use with purchases from a retail pharmacy amount to 281 euros. For the individuals included in the counterfactual, we assume they would have started their birth control pill use at the same time in the absence of a free program. The counterfactual thus calculates what an individual would spend were they to start the use of birth control pills at the same time they started the program and continue it for the duration of their observed program spell and one year onward.

Another assumption we make is the individuals would have started using birth control pills with the same initial product. This influences the way one should interpret the magnitude of the counterfactual monetary (dis)benefit. As said, a large share of

[46]The extent to which we can observe this for all women in program municipalities is affected by the way they are identified to be a part of the sample. As explained in Section 3, some municipalities give a prescription at the start of the enrollment to the program and other municipalities only once the women exit the program. We can only identify the start of the spell for those residing in municipalities with electronic prescriptions made at enrollment.

individuals initially receive the most expensive product. The counterfactual thus serves as an upper bound for the monetary amount spent on birth control pills. If they were to initially receive the product with the cheapest price at the time they begin their contraception, their spending would likely be less.[47] Similarly, the so-called post-program period length could be varied. This would increase the spending further. It should also be noted this counterfactual does not rule out history dependence per se. An individual is more likely to purchase a given product have they purchased it before. This also has implications for firms.

For firms, moving demand to the retail pharmacy side also has effects on revenue and profits, which Figure 10 indicates. In the baseline, firms are making revenue and profits from consumers for the time they purchase (i.e. outside of free programs). In the counterfactual, the individuals are consumers in the retail pharmacy market for the time they would have been in the programs. Revenues and profits for all firms increase, although there is variation in the magnitudes. Branded and parallel-imported products gain more than generics. It should also be once again noted that the counterfactual is performed on a subsample of those for whom we are reliably able to observe the start of birth control pill use. Therefore when analyzing the figures, the levels should be interpreted as illustrative rather than representative of the full market population.

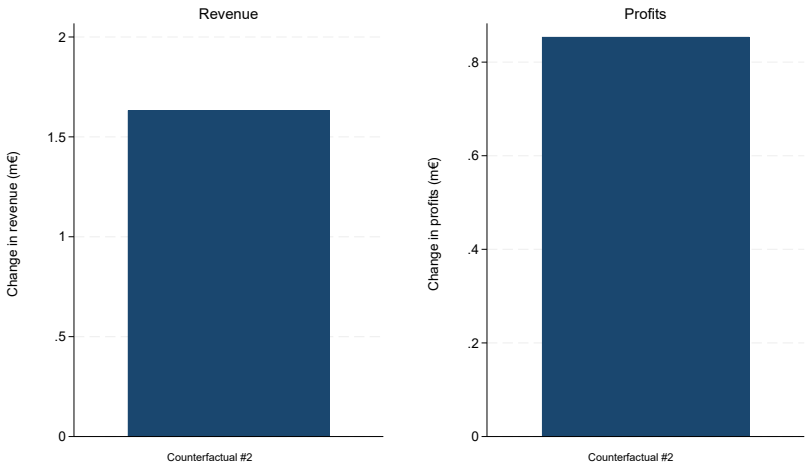


Figure 10: Firms' revenues and profits in the scenario of counterfactual #2

[47] As noted earlier in Section 4.3, the prices have remained quite constant throughout our sample period.

The market shares stay relatively constant. Branded and parallel imports gain some market share, whereas generics lose a small share. From the firm perspective, the counterfactual is in some sense incomplete, as it does not involve pricing dynamics. In other words, firms price as observed in the retail pharmacy market, not taking into account the expanded market size. If pricing would be relaxed, prices would be likely to decrease. It is also likely that removing the hospital market could affect the degree of history dependence, which could ultimately lead to similar effects as what we document in the first counterfactual. The stability of the market shares follows from this assumption.

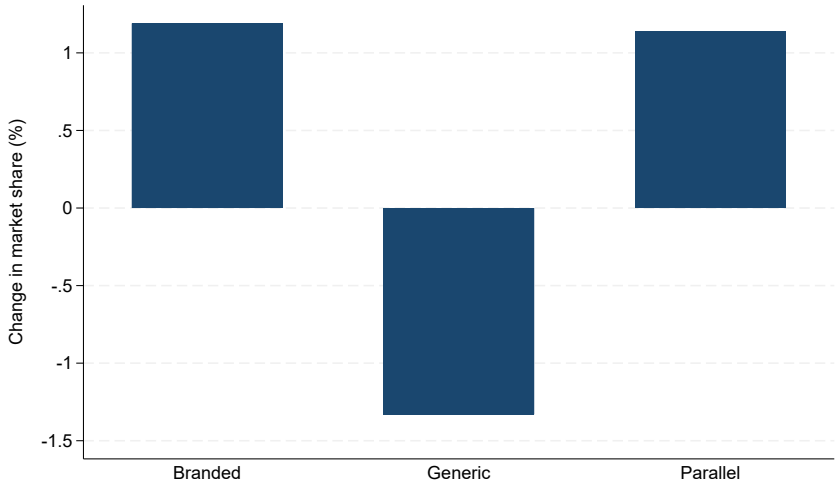


Figure 11: Market shares over brand types in the scenario of counterfactual #2

This counterfactual can also be discussed from the viewpoint of the government. As the counterfactual abolishes the hospital sector and moves all demand to the retail pharmacies, the direct effect on the government expenditure is positive. They no longer have to pay for the free contraceptives supplied in the free programs. The government collects a tax from pharmacies based on their turnover.[48] An increased market size thus equates to increased tax income for the government. This is, of course, a very narrow definition of the benefits and costs. The counterfactual assumes no individuals move to the outside option. In reality, if the individuals are extremely budget-constrained, which they well may be due to their

[48]Pharmacies in Finland are required to pay an annual pharmacy tax to the state, which is based on their turnover. The idea behind the pharmacy tax and the pharmaceutical tariff is to reduce income differences between pharmacies. The amount of tax is set according to a scale defined in the Pharmacy Tax Act, where the tax increases as turnover rises.(Fimea, 2025b)

young age, they may not begin using birth control pills at all if they are not provided for free. Less purchased products decreases pharmacy taxes collected by the government.

Discussion

The counterfactuals shed light onto the policy implications of the analysis presented in this paper. In implementing the counterfactuals, we need to make some simplifying assumptions, therefore leaving room for future work. All the counterfactuals require one implicit assumption, which is that there are no changes at the extensive margin. In other words, all of those enrolled in the programs would have started using birth control pills at the same as they enrolled in the program even when no programs were available. This assumption has implications on welfare, a concept we have thus far abstracted away from purposefully. In reality, it is likely that not all individuals would begin using birth control pills if they were not offered to them free of charge. Abolishing the free programs is likely to affect take-up and through that also welfare in its classical meaning. We leave these types of calculations for later work.

Additionally, the nature of the demand and supply stages affect what types of counterfactuals we are able to produce and to what extent we are able to model the dynamic effects of counterfactual policies. Firstly, it should be noted our sample only includes substitution groups that are not price regulated. This simplifies estimations, as we need not account for the implications maximum wholesale price regulation would have on the first order conditions of firms. If we were to simulate counterfactuals with some degree of price regulation present, we would need to model this explicitly in both the demand and supply stages.

Secondly, the supply is of a static nature. This currently prohibits us from analyzing dynamic effects of counterfactual policies. An example of such a policy would be a case where each individual in the free program would be given the product for free that is currently the cheapest in the retail pharmacy. This type of procedure would induce new dynamics into the competitive environment and require us to model the supply stage as a dynamic setting. As mentioned, modeling the supply stage dynamically is possible and we are currently working on the extension.

8 Conclusion

We study how free contraception programs affect later consumer purchase behavior and to what extent true history dependence exhibited by consumers affects pricing strategies of pharmaceutical firms. To answer these questions, we develop a tractable structural model of demand and supply for the birth control pill retail pharmacy market that embeds history dependence and price setting of pharmaceutical companies. The model is estimated using Finnish individual-level prescription and purchase data.

The results of the structural model highlight the importance of accounting for true history dependence when modeling the birth control pill market and possibly other pharmaceutical markets. It highlights that policy interventions can have long-lasting effects on demand and market outcomes, as free programs significantly affect later purchase decisions of individuals, even when pharmacists are obligated to offer the cheapest alternative when a consumer is making a purchase decision.

Pharmaceutical firms also respond to the history dependence of the consumers in their strategic decisions. The hospital pharmacy market is characterized by low prices determined through procurement auctions of hospital pharmacies. In the hospital markets, firms price their products below marginal cost. In the retail pharmacy markets, the firms rely on the history-dependent consumers to keep purchasing the same products they have received in the free programs. These products have, in almost all cases, explicitly higher prices than their substitutes. For the firms, the invest-and-harvest strategy pays off only if they are able to collect the rents from the history-dependent consumers in the retail pharmacy stage. Our back-of-the-envelope calculations reveal firms investing in the hospital pharmacy market are harvesting the rents from the retail pharmacy markets and making a profit.

The consumers benefit from the existence of the programs for the years they are eligible and enrolled in one: they receive birth control free of charge. After the programs they more often than not end up paying more out of pocket than they would were they to switch. With these particular drugs, the only difference between the products is often just the packaging. Furthermore, the products the consumers get locked in on are often the most expensive.

For the government, the current system is very inexpensive, but as the second

counterfactual suggests, abolishing the free programs could lead to immediate savings and increased revenue through pharmacy tax. As there is no reimbursement costs from the retail pharmacy stage, the only costs they currently bear come from the hospital pharmacy market. The prices in that market are low, hence total costs are low. Apart from the direct costs of the pharmaceuticals, organization of free contraception programs is naturally not costless. Programs have become widespread, and the total economic costs and benefits remain to be studied.

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Appendix

A Retail pharmacy regulation in Finland

A.1 Reference pricing system

The reference price (RP) system in Finland applies to all pharmaceuticals that are a part of generic substitution. In the system, drugs are divided into groups based on the active ingredient's strength, package size and dosage form[49]. Package sizes do not have to be exactly same, but rather closely corresponding. The products within a RP group should be substitutes. Substitutability is determined based on a list of interchangeable drugs maintained and updated by the Finnish Medicines Agency. (Pharmaceuticals Pricing Board, 2024a)

Each reference price group has a reference price. Pharmaceutical firms submit price notices to Hila on a quarterly basis and the reference price is determined by adding 0,50 euros to the VAT-inclusive[50] price of the cheapest product in each group. The reference price is thus valid for three months at a time, although pharmaceutical firms can change their own price every two weeks within the 3-month period if they wish to do so. (Pharmaceuticals Pricing Board, 2024a) Reference pricing was introduced in 2009. Originally, the RP was defined by adding 1,5 euros to the price of the cheapest product within a substitution group if the retail price was less than 40 euros and 2,5 euros to the cheapest price if it was over 40 euros (Kortelainen et al., 2023).

So-called parallel imports were introduced to the RP system in 2017. Parallel imports are drug products that are placed into circulation in one country, and then imported into a second country. Originally, parallel imports could only be included in the RP group if there were other generics available. In practice removing the condition meant that parallel importing may take place even during a patent-protected period. (Kortelainen et al., 2023)

[49] E.g. tablet, capsule, injectable solution, powder

[50] The VAT rates are as follows: medicines, 10%; clinical nutrients sold without a prescription, 14%; and emollient creams, 24%.

A.2 Retail pharmacy pricing

There are several governing bodies in the Finnish pharmaceutical markets. On the EU-level, the European Medicines Agency (EMA) is responsible for scientific evaluation of centralised marketing authorisation applications, and the European Commission issues the marketing authorisations. A pharmaceutical firm that wishes to operate in Finland has to apply for a sales authorisation from the Finnish Medicines Agency (Fimea), on the condition that they have obtained the EMA authorisation. The Pharmaceuticals Pricing Board (Hila) is responsible for initial negotiations and organizing further auction-like pricing mechanisms to determine prices as well as granting reimbursement statuses to drugs.

The decree on pharmaceutical tariffs by the Finnish Government determines how pharmacy retail prices are formed. The decree is in place to contain costs and ensure retail prescription drugs are nationally priced. The retail prices of prescription drugs are calculated by using a tiered formulas for different wholesale price levels. These are presented in Table 16. (Fimea, 2023)

Table 16: Retail pricing formulas of prescription drugs

	Wholesale price	Retail price
After 01/01/2015	0–7.49	1.42 × wholesale price
	7.50–39.99	1.35 × wholesale price + 0.52 e
	40.00–99.99	1.24 × wholesale price + 4.92 e
	100.00–399.99	1.15 × wholesale price + 13.92 e
	400.00–1 499.99	1.10 × wholesale price + 33.92 e
	>1 500.00	1.00 × wholesale price + 183.92 e
Before 01/01/2015	0–9.25	1.5 × wholesale price + 0.50 e
	9.26–46.25	1.4 × wholesale price + 1.43 e
	46.26–100.91	1.3 × wholesale price + 6.05 e
	100.92–420.47	1.2 × wholesale price + 16.15 e
	>420.47	1.125 × wholesale price + 47.68 e

The cost containment policy is enforced through competition in the wholesale prices. If a product holds a patent and is reimbursable, the pharmaceutical manufacturer has to negotiate a maximum wholesale price for the product. This is done with Hila. (Fimea,

2023) Although the system does not exactly correspond to external reference pricing, where maximum prices are determined based on the product's prices in other countries, Hila uses foreign prices for reference when the maximum price is set (Siikanen, 2019). For markets with expired patents for the originator drugs, the wholesale prices are determined through auction-like mechanisms every quarter (see Appendix **??**).

A.3 Reimbursement of pharmaceuticals

Oral contraceptives used for contraceptive purposes are not part of the Finnish drug reimbursement system, which means a consumer using the products will pay for the product entirely OOP, unless they reside in an area with a FOC program and qualify for it. It is possible to gain reimbursement for oral contraceptives if they are used for the treatment of an illness, but this must be registered in the reimbursement system with a main treatment purpose of something other than contraception, for example acne or endometriosis treatment. This is atypical in the case of oral contraceptives, as they are mainly used for contraception. The reimbursement scheme for oral contraceptives in Finland is similar to the other Nordic countries. In Finland, Denmark and Norway oral contraceptives are not typically a part of the national reimbursement systems (European Parlimentary Forum, 2023). In Sweden, oral contraceptives are part of the normal reimbursement system and for women under 21 they are free of charge (TLV, 2019).

Currently, there is a yearly initial deductible of 50 euros for all reimbursable drugs. Children and youth are exempt from the initial deductible and it is applied from the beginning of the year when a person will reach 19 years of age. After meeting the initial deductible, the basic reimbursement rate is 40 percent. The lower special reimbursement rate is 65 percent. The higher special reimbursement rate is 100 percent, but you almost must pay 4,50 euros OOP for each purchased product. These rules apply until reaches the maximum annual limit on OOP expenses of 626,94 euros. After this, one pays a 2,50 euro co-payment for each reimbursable medicine for the rest of the year. The reimbursement is typically provided directly in the pharmacy. If the purchased product is part of the above-mentioned reference price system, the reimbursement will be based on the reference price. This means that if the price of the product is higher than the reference price, the consumer will pay the difference OOP and is not reimbursed for that price. (Kela, 2024) If a consumer has a prescription for multiple purchases of a given drug, they will only be reimbursed for the new dispensement if the previous one has nearly ran out[51]. It should be noted that a product can generally only be reimbursed, if Hila has accepted the

[51]For a 1-month dose, you may repurchase after 3 weeks, for a 2-month dose 6 weeks after, for a 3-month dose 9 weeks after et cetera.

application for reimbursement from the pharmaceutical company and it is valid (Pharmaceuticals Pricing Board, 2024a).

The current reimbursement system was introduced in 2016. The reimbursement system has remained fairly similar over the years, although the annual OOP limit has increased over the years[52]. In 2016, the basic reimbursement rate was increased from 35 to 40 percent. The special reimbursement percentages were the same prior to 2016, but the co-payment was slightly less, 3 euros, for the special reimbursement rate of 100 percent.

[52]2016: 610,37 €, 2017–2018: 605,13 €, 2019: 572 €, 2020: 577,66 €, 2021: 579,78 €, 2022–2023: 592,16 €

A.4 Advertisement campaigns for birth control methods

Although advertising of prescription drugs is prohibited, drug manufacturers have launched informational campaigns about contraception in general. Figure 12 shows a screen capture of a website made by Bayer, one of the largest manufacturers of birth control pills and IUDs in Finland. The banner includes information on what to do if one has forgotten to take a birth control pill, stating that it happens to everyone. Below are a test one may take to figure out which method of contraception is suitable and a 3-step guide to read before one goes to the doctor to discuss beginning the use of hormonal contraception.

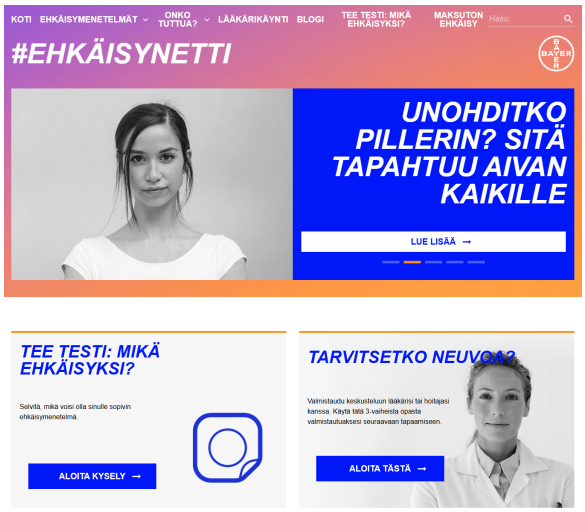


Figure 12: Screen capture of Bayer's Ehkäisynetti website (9/25)

B Joint procurers

Table 17: Joint procurers and their members by wellbeing services county

Joint procurement area	Wellbeing services county
HUS Pharmacy	Helsinki Uusimaa South Karelia Kymenlaakso Päijänne-Tavastia
VARHA pharmaceutical joint procurement	Satakunta Southwest Finland Ostrobothnia Åland
TAYS specialized care area	Pirkanmaa South Ostrobothnia Tavastia Proper
KYS specialized care area joint procurement	Southern Savonia Eastern Savonia Central Finland Northern Savonia North Karelia
PPHVA pharmaceutical joint procurement	Kainuu Central Ostrobothnia Northern Ostrobothnia Länsi-Pohja Lapland

C Shortages

Shortages are relatively common in pharmaceutical markets: IQVIA (2023) reports the prevalence drug shortages has been increasing in the US as fewer cases of temporary supply issues are resolved quickly. They estimate 25 percent of all shortages last over five years. In the Finnish market, shortages are also common. A qualitative study by Heiskanen et al. (2017) analyzes shortages to be more often supply than demand-related. Reasons include small market size, small stock sizes, long delivery times, long or complex production chains, and sudden and fluctuating demand. In Finland, shortage reporting is reliant on self-reporting by firms and wholesalers. The parties are by law required to notify Fimea of upcoming shortages at least two months before withdrawal.

Shortages exist also in our sample ATC5s. To ensure shortages do not play a significant role in our demand estimations, we use shortage data from Fimea and supplement it with our individual-level purchase data. The data from Fimea covers years 2017–2022 of our sample. For years 2017–2019, the data only reports shortages on an ATC5-level. From 2020 onward, shortages are reported on the product-level. For manufacturers and marketing authorisation holders of parallel imports shortage notifications to Fimea are voluntary, as the availability of parallel-distributed products is associated with inherent uncertainty. In our Fimea data in years 2020–2022, we observe roughly half of all shortage notifications are from marketing authorisation holders that are parallel importers, which indicates that even though the procedure is voluntary, many report their shortages. Fimea's shortage data is supplemented with our retail pharmacy purchase data. We observe a pseudonymized pharmacy id, which allows us to analyze whether a given drug was purchased at a pharmacy on a given day, week or month. Although it does not perfectly account for possibilities of shortages, it provides detailed information on availability on a pharmacy-level. We do not observe that pharmacies have been out of stock of the products listed in Fimea's shortage list during our sample period.

Table 18 shows the average lengths of shortages and products affected between 2017–2022 across all ATC5s in Finland. An average shortage lasts for 92 days and affects on average 559 products.

Table 18: Shortages across all ATC5s in Finland between 2017–2022

Year	Average length of disruption in days	Unique products affected
2017	101.52	353
2018	96.48	405
2019	75.83	554
2020	106.203	694
2021	95.40	668
2022	78.51	682

Each of our sample ATC5s has had a reported shortage at some point. Their length and extent varies. A reported shortage does not automatically mean that the drug will not be available - this will also depend on pharmacy stocks as well as the extent to which the shortage notification actually realizes. Figure 13 depicts the shortage notifications reported to Fimea between 2017–2022 for six ATC5s of oral contraceptives. Each ATC5 has had several shortage periods with varying lengths. Again, due to data use restrictions, we are unfortunately unable to report which ATC5s are presented in the figure and which of those belong to our sample.

However, we argue this does not cause a big threat to our demand model. When analyzing our purchase data, we observe the reported shortages do not affect sales quantities on an aggregated level. They also do not seem to transpire into situations where individual pharmacies would seem to run out of products when measured on a weekly level. As we observe pseudonymous pharmacy IDs, we are able to track whether a pharmacy sells a given product in a given week. Products with a shortage notification are sold throughout the sample period in almost all of the pharmacies in our sample. There are only a few pharmacies that exhibit weeks of not selling a product and this may also be because there simply has not been a consumer who has wanted to buy the product in question. If a product is not available for the consumer because of a shortage, but it is modeled to be available in the demand model, it may influence the elasticities, namely making them smaller than they should. Because we argue there are such few cases of shortages affecting the actual offering in the pharmacy, we conclude that this is not a problem.

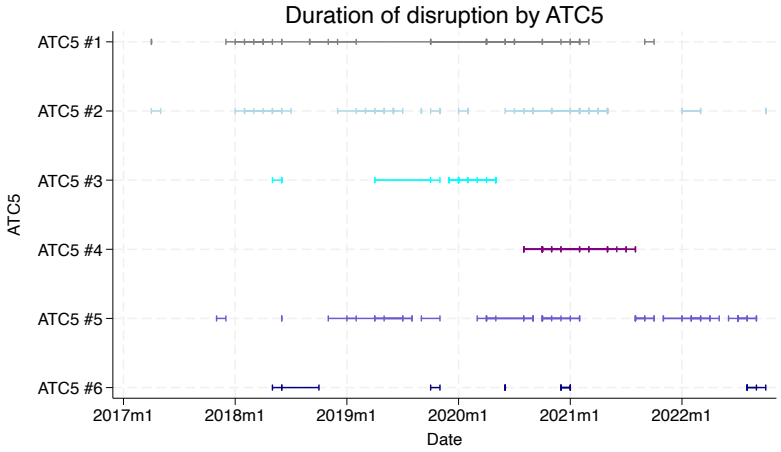


Figure 13: Reported shortages in 6 ATC5s of oral contraceptives in the ATC1 class G

Although we are confident shortages do not play a large role in measuring retail pharmacy demand, they may affect the hospital pharmacy market in ways we do not fully observe or are able to account for. Long-lasting shortages may prevent a firm or wholesaler from taking part in the hospital pharmacy procurements. Short-term shortages may alter the set of products available for eligible individuals visiting healthcare providers. As we only observe the quantities on a yearly level, analyzing shortages in the hospital pharmacy environment is difficult. The concerns are, however, slightly alleviated buy the fact that hospital pharmacies are large institutional buyers that also have relatively large stocks of the products they offer in their selection.

D Reduced form analysis

Table 19: Reduced form evidence on probability of opposing substitution

	Opposed substitution
D_{is0}	.063
	(0.009)
$Heavy_i$	-.0120
	(.009)
$Education$	-.009
	(.005)
$Heavy_i \times D_{is0}$	-.001
	(.006)
Income	Yes
Geographic FE	Yes
Substitution group FE	Yes
Observations	9 360
R^2	0.72

E Hausman-like instruments

In a perfect world, Hausman instruments used would be prices of perfect matches of products across Finland, Sweden and Denmark. Unfortunately, most products are not sold in all of these countries. We use a method similar to Markkanen (2024) and Barahona et al. (2023) to impute the DDD prices of missing products. For all packages that have an available counterpart in the neighboring countries, we use the price from the neighboring country. For the rest, we impute the price by using a hedonic regression of the form

$$\log p_{jt} = \beta \mathbf{X}_{jt} + \epsilon_{jt}, \tag{10}$$

where the dependent variable, the log retail price, is regressed on a set $\mathbf{X}$ of variables including package size as well as ATC5, firm, brand, month and brand dummies. We estimate this model separately for Sweden and Denmark and use these estimates along with the Finnish price data to predict a log price for products that do not have a counterpart available in Sweden or Denmark. These estimates are then converted to levels and used as instruments.

Alternative sets of Hausman-like instruments comprises of prices of products by the same firm. In the ATC1 class G of genito urinary system and sex hormones, there are certain ATC5s meant for treatment of solely individuals with female reproductive organs. The same pharmaceutical firms manufacture and market drugs in various ATC5s that are targeted towards different groups of women. For example, oral contraceptives will be in principal targeted for women of reproductive age, whereas drugs for menopausal hormone therapy will be used by an entirely different group of women, typically older in age than those using oral contraceptives. Using oral contraceptives and menopause drugs at the same time is not recommended and does in general not occur. However, typically both types of drugs will contain estrogen. We confirm that the menopausal hormone drug prices are correlated with oral contraceptive prices and the instrument is relevant. Some of the menopausal drugs are reimbursable, but since oral contraceptives are generally not, we are not worried about market-wide shocks such as changes in public reimbursement policies

or such that could pose a threat to the validity of the instrument and cause the prices to mutually capture demand-side effects of those.

F Price elasticities for sample

Table 20: Average price elasticities for a sample of substitution groups

(a)

	Branded drug	Competitor #1	Competitor #2
Branded drug	-1.255	.652	1.004
Competitor #1	.662	-1.705	.619
Competitor #2	1.106	.708	-1.775

(b)

	Branded drug	Competitor #1	Competitor #2
Branded drug	-1.269	.789	.945
Competitor #1	.603	-1.697	1.158
Competitor #2	.608	.976	-1.494

(c)

	Branded drug	Competitor #1	Competitor #2
Branded drug	-1.681	.805	.698
Competitor #1	1.76	-2.637	1.187
Competitor #2	1.744	1.350	-2.797

(d)

	Branded drug	Competitor #1	Competitor #2
Branded drug	-.744	1.656	.337
Competitor #1	.219	-1.473	.305
Competitor #2	.459	2.599	-2.245

(e)

	Branded drug	Competitor #1	Competitor #2
Branded drug	-1.150	.449	.591
Competitor #1	.826	-1.653	.703
Competitor #2	.910	.569	-1.361

NOTE: In each panel table, a cell gives the percentage change in market share of the row product when the price of the column product changes by one percent. Competitors may be either generic products or parallel imports.