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Abstract

The goal of this paper is to investigate and quantify the impact of parallel trade in markets for pharmaceuticals. The paper develops a structural model of demand and supply using data on prices, sales and characteristics of statins, medicines used in the treatment for high cholesterol, in Denmark. The model provides a framework to simulate outcomes under a complete ban of parallel imports, keeping other regulatory schemes unchanged. There are two sets of key results from prohibiting parallel imports. The first set focuses on price effects, which differ substantially along two dimensions: the patent protection status of the molecule and the type of the firm. On average, prices increase more in markets where the molecule has lost patent protection. On the other dimension, both generic firms and original producers increase their pharmacy purchase prices when competition from parallel importers is removed. Given the prevailing reimbursement rules, most changes in pharmacy purchase prices are absorbed by the government. The final price paid by consumers after reimbursement increases more for original firms than for generic producers. The second set of empirical results reports the effects on market participants. My model takes into consideration consumers' preferences allowing them to substitute between products. Prohibiting parallel imports induces consumers to substitute towards original products for which they have stronger preferences. In sum, banning parallel imports leads to (i) an increase in variable profits for original producers and a decrease for generic firms, (ii) an increase in governmental health care expenditures, and (iii) a decrease in consumers' welfare.

JEL classification: I18, H51

Keywords: Pharmaceutical markets, parallel trade, regulation, welfare analysis

1 Introduction

Parallel trade refers to the practice where products are legally marketed in one country but distributed in another country without authorization of the property rights holder. In the European market for pharmaceuticals, governmental health care agencies attempt to provide innovative, safe, effective and affordable pharmaceuticals keeping their financial resources. To reach this goal different regulatory policies across nations are in use. However, it has been argued that these differences in regulatory strategies generate significant price dispersion and hence induce arbitrage opportunities and a profitable market for parallel trade (Danzon 1998, Danzon and Chao 2000). Whether or not parallel imports in the pharmaceutical industry are beneficial for market participants has been an intensely debated issue. Opponents of parallel trade argue that parallel imports weaken intellectual property protection and therefore firms have less incentives to innovate, which generates dynamic inefficiency. Supporters on the other hand emphasize that allowing parallel trade benefits consumers because it increases competition leading to lower prices, which in turn generates savings to consumers and insurers. In an attempt to reduce high prices for pharmaceutical products, the European Union has allowed parallel imports within its area.[1]

The goal of this paper is to investigate the impact of parallel trade in markets for pharmaceuticals. More specifically, this paper attempts to identify and understand the effects of parallel imports on consumers' consumption choices, government expenditures for pharmaceuticals, and producers' strategies.

I empirically quantify these effects on the market participants using data on prices, sales and characteristics of statins in Denmark. Statins are used in the treatment of hypercholesterolemia—presence of high levels of cholesterol in the blood—, a chronic condition that, if left unattended, can have severe consequences like heart attacks and strokes, which are both leading causes of death in developed countries. The best known statins sell under the tradename *Lipitor* (by *Pfizer*) and *Zocor* (by *MSD Sharp & Dohme*) and are top selling medicines worldwide in terms of volume and revenue. The Danish pharmaceutical market provides a clean empirical setting to study these effects due to its unique market structure and the availability of very rich data. Denmark maintains a tax-financed universal public health insurance that provides reimbursement for pharmaceutical

[1]The United States currently referred bill S.319, Pharmaceutical Market Access and Drug Safety Act of 2011, to Senate committee on 2/10/2011 to allow parallel imports.

products but does not directly regulate price setting decisions of the firms. Hence, a particularly attractive feature of my data is that it allows me to distinguish between the price set by the firm, the price set by the pharmacy, and most importantly, the price paid by consumers, which plays the most important role in determining demand. In addition to the detailed information on how prices are established at different stages of the vertical supply chain, the regulatory stringency on pricing eliminates the need to model behavior at the distribution stage of the vertical chain, allowing a focus on consumers and firms only.

The paper consists of two parts. The first part develops and estimates a structural model of demand and supply under current regulation laws and market structure. The second part uses estimates of the model parameters and the provided framework to construct counterfactuals allowing a welfare evaluation under a complete ban of parallel imports.

Eliminating parallel trade yields the following results. First, a prohibition of parallel trade reduces unweighted average prices but results in higher prices for both original products and generic products. Second, eliminating parallel trade leads to substitution from parallel imported products towards original products. Third, consumer expenditures as well as government expenditures increase absent parallel trade. Finally, banning parallel imports reduces consumer surplus and increases firm profits, on balance leading to an overall decrease in welfare.

Finally, while beyond the scope of this paper, the long-term effects of parallel trade, particularly on generating dynamic inefficiencies that can reduce welfare, remain a highly controversial and unresolved question. Because the industry heavily relies on R&D and innovation is an important driver of consumer welfare, the subject constitutes an important issue for further research.

This paper is organized as follows. Section 2 provides a review of the relevant literature. Section 3 offers an overview of the Danish pharmaceutical market. Section 4 describes the data. Section 5 describes the empirical framework and describes the simulation strategy. Section 6 presents the results and welfare implications. Section 7 concludes.

2 Literature Review

This section offers a short summary of the literature on parallel imports. First, I present the legal framework on parallel trade in the European Union. Next, I review the literature

that has addressed parallel imports in the pharmaceutical industry from an economics perspective.

A Legal Perspective

Parallel trade deals with topics in three related fields: intellectual property law, international trade, and competition law.[2]

International research-intensive firms rely strongly on intellectual property rights to protect their investments. One important policy is the legal principle of exhaustion of patent rights, which determines the markets where the property right owner can prevent unauthorized trade. Under the Trade-Related Aspects of Intellectual Property Rights Agreement (TRIPS) each country is free to determine a national or an international policy of exhaustion of patent rights (Article 6 of the TRIPS Agreement). The European Union has adopted a policy of community exhaustion, such that property right owners can prevent resale of products first sold outside the area but cannot interfere in the trade of its products within members states of the European Union.

Furthermore, in an effort to achieve and protect an European Common Market, the European Commission and the European Court of Justice strictly enforce the principle of free movement of goods within the European Union (Article 28 of the consolidated version of the Treaty on the Functioning of the European Union (TFEU)).

Original firms have used different strategies to limit parallel trade, such as challenging restrictive distribution agreements with wholesalers, setting supply restrictions in exporter countries, or challenging trademark protection[3]. But parallel trade within the European Union has been enabled and protected through these laws that prioritize the principle of a Common Market over the possible welfare losses generated through reduced incentives to innovate. More recent cases have shed light into the importance of considering dynamic inefficiencies (Petrucci 2010, Tsouloufas 2011) and the necessity of revising the goals of the EU competition laws.

[2]See Kyle (2009) for an overview of the literature related to parallel trade in pharmaceuticals

[3]See for example: GlaxoSmithKline Services Unlimited v. Commission of the European Communities Case C-501/06, 2009 ECR I-9291; GlaxoGroup Ltd. v. Dowelhurst Ltd. & Anor Case HC 03 00464, 2003 EWHC 2015; Hoffman-La Roche v. Centrafarm Case C-1 02/77, 1978 ECR 1139.

An Economic Perspective

Most of the empirical studies on parallel imports in the pharmaceutical industry have almost exclusively focused on price effects. For instance, Ganslandt and Maskus (2004) use a regulatory change after Sweden joined the European Union in 1995. They estimate a 19 percent price reduction due to parallel imports for the top 50 molecules in Sweden.[4] In contrast, Kanavos and Costa-Font (2005) study six molecules during 1997 to 2002 in 11 European countries. They do not attribute price decreases in import countries to parallel trade, but rather to generic substitution and find evidence for entry of parallel importers to be determined by price differences between countries. A contribution that takes a different approach is Kyle (2011). She investigates non-price responses to parallel trade because in this heavily regulated industry, firms are usually limited in their price setting strategies to compete with parallel trade. Her study reveals that to counteract the competitive pressure from parallel importers original firms are indeed using non-price strategies to hinder parallel trade; typically, restricting supply, using restrictive distribution agreements and differentiating products across countries by altering the brand name, dosage form, and strength.

A more related study is Enemark et al. (2006). The authors use data on four European countries including the top 50 products in Denmark in 2004 and predict how prices would have developed in the absence of parallel importers using a reduced-form approach and the prices of original products before any competing parallel importer enters the market. They find that parallel trade generated 168 million Danish krones savings. My results contribute to the view that parallel trade does generate substantial savings to consumers and health care agencies, however, in contrast to their approach, I explicitly model and structurally estimate the change in prices taking into consideration price elasticities, patients' preferences and the strategic reaction of firms. The magnitude of the savings predicted in my model are much higher (on average 242.6 million Danish krones in the market for statins) than the results in Enemark et al. (2006) and my model highlights the importance of considering the more complex interactions between pharmaceutical companies, insurance providers and patients.

Finally, in a contemporaneous paper Duso et al. (2014) examine welfare effects of parallel trade using data on the German market for oral anti-diabetic drugs. Their results

[4] A molecule in this context is the active ingredient of a pharmaceutical product defined by its bottom-level Anatomical Therapeutic Chemical (ATC) classification code.

suggest a decrease in prices for on-patent products of 11%, no effects for generics, and a modest impact on consumer surplus. Although the geographic and therapeutic markets are different to the ones examined here, their results support my findings. However, my predicted price effects are smaller (around 3%) and my welfare effects are substantial (around 18% of the yearly market's revenue). This can be attributed to the richer data set that allows me to use more precise information, such as firm prices to calculate firm profits, pharmacy prices to calculate governmental savings and consumer prices, which are not fixed to certain levels but vary for each product, to calculate patients' price sensitivity more accurately. In addition, Denmark does not impose minimum quotas directly affecting the sales of parallel imported products at the pharmacy level and it does not use rebate contracts in the procurement for pharmaceuticals. Both of which facilitates a more clean setting to investigate my question.

The theoretical literature has gone beyond studying price effects, and explores the impact of parallel trade on R&D. Li and Maskus (2006), Szymanski and Valletti (2006), and Valletti (2006) conclude that parallel imports have detrimental effects on incentives to innovate in the long run but can be beneficial to consumers in the short run. However, Grossman and Lai (2008) show that allowing international parallel trade can benefit innovation, since governments will use different price control tools if international parallel trade were permitted. This issue, while beyond the scope of my paper, is still a relevant question.

3 The Danish Pharmaceutical Industry

This section offers an overview of the pharmaceutical industry and discusses the main regulatory framework in effect during the time period covered by my data (May 2003 to March 2005).

3.1 Industry Description

The pharmaceutical industry in Denmark has a typical vertical structure.[5] First, at the upstream level there are three types of firms: Original firms, generic firms, and parallel importers. Original firms engage in R&D and manufacture new medicines using intellectual

[5]Evidence for vertical differentiation in the market for pharmaceuticals has been provided by Brekke et al. (2011), Ching (2010a,b), Grabowski and Vernon (1992), Scott Morton (2000) among others.

property rights to protect their innovations. Generics firms produce bioequivalent copies of original products and are only allowed to enter the market after the relevant patents have expired. In contrast, parallel importers do not engage in manufacturing. Instead, they supply products that are imported from markets outside of Denmark. Typically, parallel importers repackage, relabel, and redistribute (original and generic) products. Since 1990, parallel imports are legal in Denmark—even for products under patent protection.

Second, at the wholesale level, pharmacies purchase pharmaceuticals from upstream firms that are supplied to consumers (patients). Pharmacies operate in a highly regulated market environment, as I detail below. The most important features of the regulation are: generic substitution and retail price regulation.

Finally, at the downstream level, consumers purchase prescription-only pharmaceuticals from the pharmacies. At the consumer level, the regulator implemented a system of reference pricing that sets reimbursement rules. Importantly, the reimbursement price determines copayment prices, which govern consumers' purchase decision. Figure 1 illustrates the vertical structure.

Other relevant market features are that Denmark maintains a universal health care system that is financed through general tax revenues; advertising prescription drugs directly to patients is prohibited; and detailing, marketing to physicians, is highly regulated and only allowed for original firms introducing new molecules.

3.2 Regulatory Framework

Governmental safety concerns and budget constraints generate a high degree of regulation on pharmaceutical markets. In Europe, price regulation and reimbursement rules of pharmaceuticals is a national competence. Denmark's regulatory body has adopted a policy of free pricing at the upstream level. However, the upstream firms must report their prices to the Danish Medicines Agency (DKMA). Every second week, the DKMA updates prices and product availability in a publicly available list. This list is used by doctors when issuing prescriptions, by hospitals for their electronic patient records, by pharmacies to ensure availability of products, and by consumers to obtain information about (copayment) prices of available substitutes. Next, I discuss pharmacy regulation and follow it with a description of the reimbursement rules that determine copayment prices.

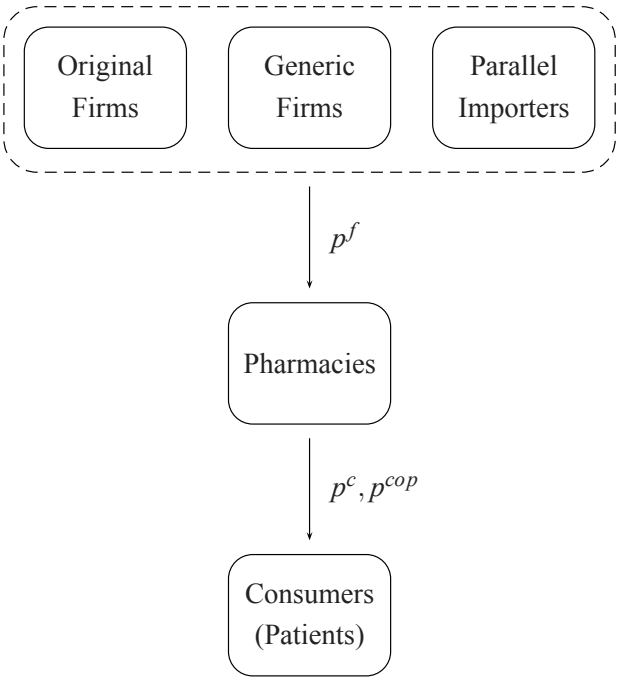

Figure 1: Overview of vertical industry structure

3.2.1 Pharmacy Regulation

Pharmacies face two types of regulation: generic substitution and retail price regulation. Danish pharmacists are required by law to dispense the cheapest product among available substitutes, unless the consumer or the doctor explicitly requests another product. Generic substitution for off-patent products has been encouraged since 1991.

Pharmacy retail prices p^c for prescription-only pharmaceuticals are identical nationwide and can be decomposed as follows:

$$p^c = \mu p^f + k, \tag{1}$$

where p^f is the pharmacy purchase price (at the wholesale level), μ is the regulated markup above the pharmacy purchase price, and k is the prescription fee (including value added tax).[6] Notice that, in effect, retail price regulation determines pharmacies' unit margins.

[6]The exact rules and yearly adjustments to compute pharmacy retail prices from pharmacy purchase prices are detailed in Appendix A.

3.2.2 Reimbursement Rules

The final price paid by consumers is the copayment price, that is, the pharmacy retail price adjusted for reimbursement. Specifically, the copayment price p^{cop} is given by:

$$p^{cop} = p^c - 0.8 * p^r, \tag{2}$$

where p^c is the pharmacy retail price and p^r is the reference price. The reference price for a given product is set equal to its own pharmacy retail price as long as it is below the average price in EU-15 (excluding Greece, Luxembourg, Spain, and Portugal). The 80% reimbursement of the reference price applies for consumers with yearly expenditures exceeding 2,950 Danish krones (DKK) (€395).[7]

Substitution groups are defined by DKMA guidelines. Products are assigned to the same substitution group if they have the same active ingredient, administration form, strength, and similar package size. Importantly, consumers can freely choose among products in the same substitution group.

This reimbursement rule, while allowing consumers some freedom in their choices, does influence consumers' price sensitivity by covering only a fraction of their expenditures. Therefore, reference pricing is a widely used measure for cost containment (López-Casasnovas and Puig-Junoy 2000; Espín et al. 2011).[8] Brekke et al. (2007, 2009, 2011), Kaiser et al. (2014), and Pavcnik (2002) empirically investigate the impact of reference pricing on consumer and government expenditures.

4 The Data

I use data from the market of statins during the time period May 2003 to March 2005. Price data and product characteristics were obtained from DKMA. Sales data was made available from the Danish Association of the Pharmaceutical Industry (LIF). I observe fortnightly prices and sales for 213 products sold in Denmark, which belong to the molecules in the therapeutic group of HMG CoA reductase inhibitors (commonly known as statins).

A product is defined by four attributes: active substance, strength, package size, and

[7] The medical condition explored below is a chronic condition for which this minimum expenditure is reached.

[8] The WHO Collaborating Centre for Pharmaceutical Pricing and Reimbursement Policies (online access at *http://whocc.goeg.at*) offers an overview of the countries that currently use reference pricing to control expenditures.

firm. The active substance is captured by the molecule classified by the 5-level ATC code. Strength measures the amount of the active substance in milligram per pill. Package size is simply the number of pills per package.

There are six molecules, out of which three are off-patent or lost patent protection during the observed time period (Simvastatin, Lovastatin, and Pravastatin). The other molecules are on-patent (Fluvastatin, Atorvastatin, and Rosuvastatin). Table 1 provides an overview and indicates the ATC codes. In addition, the table provides information about brand names, patent owners and the average number of firms and products in each molecule. The best known statins sell under the tradenames *Lipitor* (*Pfizer*) and *Zocor* (*MSD Sharp & Dohme*) and are top selling medicines in terms of quantity and revenue. In 2004 the Danish market for statins generated around DKK 320 million (€43 million).

Generic firms also sell versions of the first three molecules (C10AA01-C10AA03). In contrast, the molecules Fluvastatin (C10AA04), Atorvastatin (C10AA05), and Rosuvastatin (C10AA07) are protected by an active patent and sold by original firms and parallel importers only.

To make different products comparable I normalize prices and quantities using defined daily doses (DDD). This measure is proposed by the World Health Organization and widely used in the pharmaceutical industry.

Table 2 shows average pharmacy purchase prices p^f, pharmacy retail prices p^c, reference prices p^r and copayment prices p^{cop}. All prices are deflated using consumer price index with 2005 as basis year. The summary is organized as follows: Part A shows averages for all products, Part B presents the results by molecule, Part C by firm type, and Part D by the patent status. Pharmacies buy one DDD for around DKK 6 (around €0.80) and consumers copayment is on average DKK 3.2 (€0.40). As noted in Kanavos and Costa-Font (2005), the pharmacy purchase price for parallel imports lies just below the price for original firms and significantly above generic prices. This could be attributed to the fact that most of the parallel imported products are potentially produced by original firms. This is clear for the three on-patent molecules, while for the off-patent molecules I do not directly observe the country that exported the parallel imported product, but I use as a proxy information about the name under which the product is marketed in Denmark. For safety reasons this should be the same trade name under which the product is marketed in the exporting country and generic firms can not use trademark protected names. Finally, copayments seem to be substantially higher for original products than for parallel imports

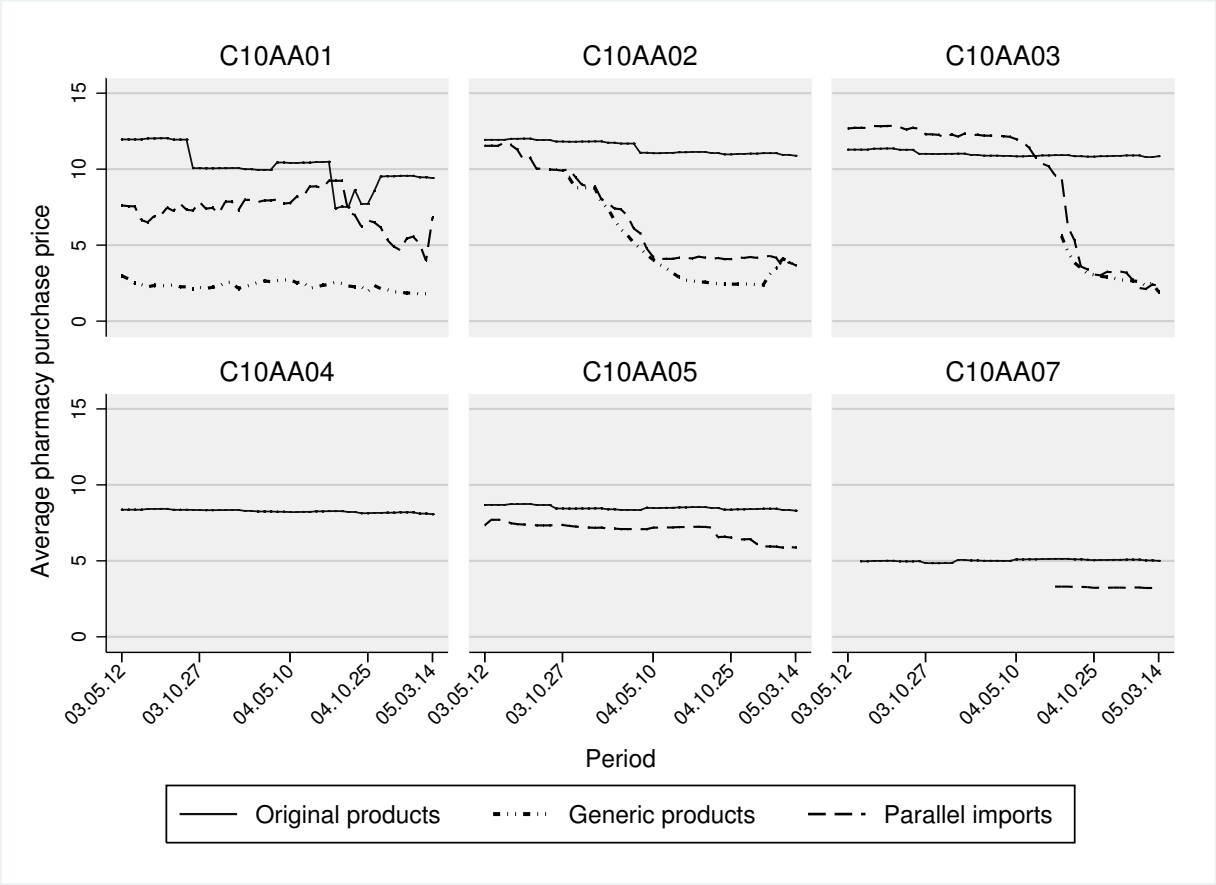

Figure 2: Average pharmacy purchase price over time

or generics. Also, consumers pay more for off-patent products than for on-patent products. This is due to the reimbursement rules and the lack of substitutes in the on-patent segment.

Further, Figure 2 shows average pharmacy purchase prices per DDD over time for each type of firm in the six different molecules. Prices for original products are very stable even in the presence of generic products or parallel imports. On the contrary, parallel imports seem to engage in competition with generics once they enter the market. This is mainly visible in the graphic from Lovastatin (C10AA02) and Pravastatin (C10AA03) where generic entry is clearly observed and is followed by a drop in average prices from parallel imports and generics.

Finally, Table 3 summarizes average sales and revenues, and expenditures. Fortnightly sales are in volume and amount to about 2.4 million DDD on average for a period of 14-days. The most popular products are Simvastatin (C10AA01) and Atorvastatin (C10AA05) selling fortnightly on average around 1.7 million DDD and 0.5 million DDD

respectively. Furthermore, most sales come from generic products. Revenues are calculated as pharmacy purchase price times sold DDDs. The market for statins generates fortnightly on average DKK 9 million. Original firms account for the highest revenues, while revenues for generics and parallel imports are substantially lower. Government expenditures are reimbursement costs and amount to DKK 10.3 million on average for a period of 14-days. Finally, consumers pay only a fraction of their cost (copayment price times consumed DDDs). Their fortnightly expenditures are on average DKK 3.3 million.

5 Empirical Framework

The empirical framework has two main components: demand estimation and supply estimation. The estimation draws on Berry (1994), Stern (1996), and Verboven (1996), and contributes to a growing literature on structural estimation in the pharmaceutical industry as seen in recent work by Branstetter et al. (2011), Ching (2010a, 2010b), Dubois and Lasio (2014), Dunn (2012), Dutta (2011), and Kaiser et al. (2014). The first part of this paper specifies a discrete choice model to estimate consumer demand. These estimates are used in the second part to recover the marginal cost of production from the firms' profit maximizing conditions. Ultimately, the goal of the analysis is to use the estimates to generate policy implications from a hypothetical ban of parallel imports.

5.1 Demand Estimation

I consider a market with a set of consumers that are indexed by i. Each consumer chooses the product j ($j = 1, \ldots, J$) that maximizes her utility U_{ij}. Consumer choice has a nested logit structure (Berry 1994). The nests structure follows from substitution groups defined by the DKMA and represents the prescription ordered by the practitioner. Each nest ($g = 1, \ldots, G$) includes all original, generic and parallel imported available products in the same substitution group. Importantly, consumers can freely choose among products in the same substitution group.[9]

The utility of a consumer as a function of observed and unobserved product characteristics is:

$$U_{ij} = X_j\beta - \alpha p_j^{cop} + \xi_j + \sum_g [d_{jg}\zeta_{ig}] + (1-\sigma)\varepsilon_{ij}. \tag{3}$$

[9] Consumers can choose a product that belongs to a different substitution group only after consulting the practitioner. I allow for this possibility in my estimation.

The terms that are invariant across consumers are captured by mean utility $\delta_j \equiv X_j\beta - \alpha p_j^{cop} + \xi_j$, which depends on observed product characteristics X_j, copayment price p_j^{cop} and product characteristics ξ_j (that are unobserved to the econometrician).

The nesting structure is reflected in d_{jg}, a dummy equal to one if product j belongs to the set of products J in nest g (J_g) and zero otherwise. ζ_{ig} is common to all products in nest g and its distribution depends on the nesting parameter σ. The random utility term ε_{ij} represents unobserved consumer-specific heterogeneity. Each ε_{ij} is assumed to be identically, independently distributed extreme value across consumers and products. Cardell (1997) shows that if ε_{ij} is i.i.d. extreme value, then $\zeta_{ig} + (1-\sigma)\varepsilon_{ij}$ is also an extreme value random variable.

The nesting parameter measures correlation of consumer choices between substitution groups. Products are considered closer substitutes the closer σ gets to one. If $\sigma = 1$ the model reduces to a simple logit model where there is perfect substitutability of products between nests. On the contrary, if $\sigma = 0$ there is no substitution across nests. For the nested logit to be consistent with random-utility maximization, the estimated value for σ must lie between 0 and 1 (McFadden, 1978).

The model also includes one nest that is explicitly modeled as the outside option. It allows consumers with high cholesterol to be treated with drugs other than statins or where no medication but rather lifestyle changes such as more sports and a low-fat diet are recommended. In absence of the outside option a change in prices of the inside goods, statins, will not have an effect on aggregate output. The price of the outside good is assumed not to be set in response to the prices of the inside goods and its mean utility is normalized to zero ($\delta_0 \equiv 0$).

If each consumer selects the product that provides them with the highest utility and using the distributional assumptions, Berry (1994) shows how to solve for mean utility levels as a function of observed market shares. The market share of product j s_j can be decomposed as follows:

$$s_j(\delta, \sigma) = s_{j|g}(\delta, \sigma) s_g(\delta, \sigma), \tag{4}$$

where $s_{j|g}$ is the share of product j in nest g and s_g is the share of nest g in the market. Following Berry (1994), these terms are:

$$s_{j|g}(\delta, \sigma) = \frac{\exp(\delta_j/(1-\sigma))}{D_g} \text{ and } s_g(\delta, \sigma) = \frac{D_g^{(1-\sigma)}}{\sum_g D_g^{(1-\sigma))}},$$

where D_g is:

$$D_g \equiv \sum_{j \in J_g} \exp(\delta_j/(1-\sigma)).$$

The nest containing the outside good has only one element ($D_o = 1$), thus the market share of the outside good is:

$$s_o(\delta, \sigma) = \frac{1}{\sum_g D_g^{(1-\sigma)}}.$$

Finally, solving for mean utility levels the linear equation to be estimated is:

$$ln(s_j) - ln(s_o) = X_j\beta - \alpha p_j^{cop} + \sigma ln(s_{j|g}) + \xi_j. \tag{5}$$

The variables included in the vector of observed product characteristics are the strength, package size, a dummy variable indicating if the product is on-patent and the number of products in the same nest. I further include firm and time period dummy variables in the specification. The key parameters are the coefficient on price α and the nesting parameter σ. These parameters will determine elasticities of demand and thereby influence the substitution patterns of consumers and the price setting of firms. My prior is that α has a negative sign such that higher prices are associated with a decrease in mean utility. The nesting parameter σ should lie between 0 and 1 to be consistent with random-utility maximization.

5.1.1 Instrumental Variables

To control for endogeneity arising from potential correlation between unobserved product characteristics and p_j^{cop} and $s_{j|g}$ Berry et al. (1995) propose the use of characteristics of other firms as valid instruments, since characteristics of product k are not included in the utility function for product j but are correlated with the price and conditional shares of product j through the markup in the first-order conditions of the profit maximizing firm in oligopolistic competition. Additionally, Nevo (2001) proposes exploiting the panel structure of the data and uses the price of the same label in other markets as an instrument, because the price of product j in two different markets will be correlated due to the common marginal cost, but market specific valuations are independent across markets. Accordingly, the instruments I use are the number of products of rival firms, the average price of products from the same firm in other substitution groups, the sum of

characteristics of rival firms, and squares of own products' characteristics.

5.1.2 Market Size and the Outside Good

Longstanding elevated levels of cholesterol in the blood induce the formation of plaque in the arteries causing narrowing or even blockage of arteries. This condition is asymptomatic and can go undetected for a long period of time generating life-threatening problems like heart attacks or strokes. Total market size includes consumption of both consumers in treatment and potential consumers with high cholesterol levels. In a similar way as Dunn (2012) or Ching et al. (2012) I use different sources to determine total market size.

The first step is to define the fraction of the population with elevated levels of cholesterol. Guidelines recommend for a healthy adult to have less than 5 millimoles per liter of blood (mmol/L) of total cholesterol and less than 3 mmol/L of low-density lipoprotein cholesterol. According to the Danish Association of Heart Patients (Madsen and Videbæk, 2004) and the Danish Institute for Rational Pharmacotherapy (IRF, 2006) around 60% of the Danish population between 40 and 80 years of age exceed these thresholds. This estimate goes in line with a report from the World Health Organization (Roth, 2011) that shows disease prevalence statistics for similar countries to Denmark, where the percentage of total population aged 40-79 years with high levels of cholesterol lies between 35% and 61%.

Second, total consumption of statins from consumers in treatment is obtained from the Danish Health Data and Disease Control Institute (www.medstat.dk). I assume that if potential consumers were prescribed with statins, they will consume the same dosage as the average actual consumer. The sum of actual consumption and hypothetical consumption from potential consumers gives total market size.

5.1.3 Price Elasticities

Finally, the price paid by consumers (p^{cop}) is the relevant price to calculate the associated elasticities. Using α and σ from the demand estimation the own price elasticity for product j in a nested logit is:

$$\eta_{jj} = \frac{\partial s_j}{\partial p_j^{cop}} \frac{p_j^{cop}}{s_j} = -\alpha \frac{1}{(1-\sigma)} p_j^{cop} [1 - \sigma s_{j|g} - (1-\sigma) s_j].$$

Cross-price elasticities are expected to be smaller if the products are consider less sub-

stitutable. If product j and product k are in the same substitution group their respective cross-price elasticity is:

$$\eta_{jk} = \frac{\partial s_j}{\partial p_k^{cop}} \frac{p_k^{cop}}{s_j} = \alpha \frac{1}{(1-\sigma)} p_k^{cop} [\sigma s_{k|g} + (1-\sigma) s_k].$$

If product j and product l are not in the same substitution group, the cross-price elasticity is:

$$\eta_{jl} = \frac{\partial s_j}{\partial p_l^{cop}} \frac{p_l^{cop}}{s_j} = \alpha p_l^{cop} s_l.$$

5.2 Supply Estimation

On the supply side of the market there are multiproduct firms that are free to choose their pharmacy purchase price (p^f). Assuming that prices are set in a Bertrand-Nash equilibrium, the profit-maximization conditions can be used to recover markups and marginal cost of production.

Each firm f, with $f = 1, \ldots, F$, produces some subset ϑ_f of the J products. The profit function of firm f can then be written as:

$$\Pi_f = \sum_{j \in \vartheta_f} (p_j^f - c_j) s_j M - K \tag{6}$$

Where p_j^f, c_j, and s_j are product j's respective pharmacy purchase price, marginal cost, and market share. M is total market size including consumption from actual and potential consumers, and K are the firm's fixed cost.

The first order condition for product j is:

$$\frac{\partial \pi_j}{\partial p_j^f} = M \left(s_j + \sum_{h \in \vartheta_f} (p_h^f - c_h) \frac{\partial s_h}{\partial p_j^f} \right) = 0$$

Each firm sets prices for each product considering the price of all of its other products. The set of J first order conditions characterize equilibrium prices and can be rewritten in vector form as $S(p^{cop}, x, \xi) - \Delta(p^{cop}, x, \xi)(P - C) = 0$, where S is the vector of shares, Δ is a $J \times J$ matrix with $\Delta = -\partial s_h / \partial p_j^f$ if h and j are produced by the same firm and $\Delta = 0$ otherwise, P is the vector of pharmacy purchase prices (p^f), and C a vector of marginal cost. Because the shares are functions of copayment prices, I use equation (1) and (2) to express everything in terms of pharmacy purchase prices taking into account

that prescriptions fees, pharmacy markups as well as the reference price are exogenously given.

Finally, the J pricing equations can be express as marginal cost and markup, where the term $\Delta^{-1}S$ is a measured of predicted markups:

$$P = C + \Delta^{-1}S \tag{7}$$

5.3 Counterfactual Calculation

Removing parallel importers from the market affects the market participants in different ways. Firms face less competition which is associated with an increase in prices. Consumers, additionally to facing higher expenditures due to the increase in prices, are confronted with less variety. Consumers that consumed parallel imports substitute towards generics, original products or to the outside option. Finally, the effect of a ban of parallel imports on governmental expenditures depends on the magnitude of changes in prices and the new choices of consumers. If, for example, former buyers of parallel imports choose original products and their prices rise, then government expenditures would most likely increase, since prices for original products are on average higher than prices for parallel imports even before the prohibition.

To calculate the new equilibrium I use the following three equations. First, I follow the Danish rules and regulations and use equation (1) and (2) to obtain the counterfactual copayment prices[10] as follows:

$$p^{cop}_{j_{counter}} = \mu p^{f}_{j_{counter}} + k - 0.8 * p^{r}_{j}. \tag{8}$$

Second, eliminating parallel imports does not affect consumers tastes, therefore I use equation (4) to obtain counterfactual shares for each product:

$$s_{j_{counter}}(\delta_{counter}, \sigma) = \frac{\exp(\delta_{j_{counter}}/(1-\sigma))}{D_g} \frac{D_g^{(1-\sigma)}}{\sum_g D_g^{(1-\sigma))}}, \tag{9}$$

where $\delta_{j_{counter}} = X_j\beta - \alpha p^{cop}_{j_{counter}} + \xi_j$. Finally, removing parallel imports does not affect marginal cost of production of the remaining firms. Using the same Bertrand-Nash equi-

[10]The reference price is updated as long as the counterfactual pharmacy retail price remains below the European average price. Otherwise it is set equal to the prevailing average European price.

librium assumptions for the price setting behavior of the firms, I calculate counterfactual pharmacy purchase prices using the marginal cost implied by the demand estimates as follows:

$$P^{f}_{counter} = C + \Delta^{-1}_{counter} S_{counter} \tag{10}$$

Solving equations (8), (9), and (10) simultaneously yields the counterfactual market equilibrium prices and shares.

5.4 Consumer Surplus and Welfare

Consumer surplus is (Small and Rosen 1981):

$$CS = \frac{1}{\alpha} M \ln \left[1 + \sum_{g=1}^{G} \left(\sum_{j \in G_g} exp^{\delta_j/(1-\sigma)} \right)^{(1-\sigma)}. \right] \tag{11}$$

I use equation (11) to calculate yearly consumer surplus with the real data and with the counterfactual data. The difference $CS_{real} - CS_{counterfactual}$ measures the effects on consumer surplus generated by prohibiting parallel imports. This measure not only accounts for possible harm induced by price increases, but, because it takes consumers' preferences into consideration, it also captures losses generated by reducing the market variety.

Finally, I define total welfare as the sum of consumer surplus and firms' profits. The difference between real total welfare and counterfactual total welfare mirrors the changes in total welfare from a prohibition in parallel trade.

6 Results

This section reports three sets of empirical findings. First, it presents estimates of the utility parameters and the implied elasticities. Second, it reports cost estimates for the different firm types. Third, the section provides policy implications from a counterfactual analysis.

6.1 Demand

Estimating the demand side in (5) yields the empirical counterparts of the utility parameters and the substitution parameters. As expected the coefficient on copayment price is

negative and the nesting parameter is positive.

Estimates are provided in Table 4. The estimated OLS coefficient on copayment price α is close to zero (-0.053). When controlling for endogeneity, the estimate is clearly negative, as expected. This means that a higher copayment price reduces consumers' mean utility. Specifically the IV - nested logit estimate of α is -0.832. These estimates are in line with previous findings: Dunn (2012) finds a price coefficient of -1.61 for anti-cholesterol drugs based on US data covering the period 1996 to 2007. Similarly, Branstetter et al. (2011) obtain a price coefficient of -0.30 for the market of hypertension drugs in the United States between 1997 and 2008.

The OLS estimate of the nesting parameter σ is 0.803, which shows a relatively high degree of substitution across different product groups. The degree of substitution is lower when controlling for endogeneity. In this case the estimate of σ is 0.315. Both estimates lie between zero and one (which is consistent with random-utility maximization) and are slightly higher than the value 0.24 reported in Dutta (2011).

The estimation of the utility parameters yields further insights. First, products with less strength (-0.807) and more pills per package (0.018) are associated with higher market shares. The coefficient on products in groups with patent protection is positive (1.697), while the coefficient on the number of products in each substitution group is negative (-0.212), suggesting that a less competitive environment has a positive impact on market shares. Second, the firm dummies coefficients indicate that consumers have a strong preferences for original firms, followed by parallel importers.

The empirical insights regarding the substitution patterns are summarized in Table 5. It presents the mean own and cross-price elasticities of demand associated with the coefficient estimated from the IV - nested logit and shows that the own-price elasticities are negative and the cross-price elasticities are positive. Part A reports the average elasticities for all products. The mean own-price elasticity is -3.608 and is very similar to the obtained result in Dunn (2012) of -3.11. The results on cross-price elasticities are as expected small and much lower if products belong to different substitution groups. Part B of Table 5 reports average elasticities for products in each molecule group. Part C of the table reports elasticities for products in each type of firm. Original firms and parallel importers, which charge higher prices, have higher elasticities than generics. The lower own-price elasticity of generics support the important role of pharmacy incentives (in the Danish case through the rules on generic substitution) (Brekke et al., 2013). Finally, Part D summarizes the

results for products off-patent and on-patent. Mean own-price elasticities are higher if the product is off-patent, which is expected to be a more competitive segment.

6.2 Supply

This section uses the results from the demand side to estimate the supply side in (7). The estimated average marginal cost of production for a unit of DDD is DKK 5.28 (see Table 6). This cost estimate is below the average pharmacy purchase price of DKK 5.93 (reported in Table 2), implying an average unit margin of DKK 0.65 or 21 percent of the pharmacy purchase price. Table 6 also reports average production cost and markups at the molecule level, for all three types of firm and by patent status. All marginal costs are positive and of comparable size. This is evidence that price differences across molecules are the result of differences in markups rather than differences in marginal cost of production. The markups are slightly lower than the price-cost margins reported by Dubois and Lasio (2014) and Brekke et al.(2013). But they are in line with their findings that original firms have lower margins than generic firms. This is attributed to lower cost of production of generics in comparison to original products.

Interestingly, the table shows that markups differ by the patent status of the molecules. Markups are lower for off-patent molecules and higher for on-patent molecules in absolute values. This result nicely illustrates that competition from generics erodes unit markups, especially for original firms: the on-patent molecules generate higher markups than the off-patent molecules because there is only competition due to parallel imports but not from generics (see Part D of Table 6).

Finally, unit markups from generics are relatively high if compared to other geographic markets. This can be attributed to the prevailing reimbursement system. The reference price for a given product is set exogenously at its pharmacy retail price if it is lower than the average EU price creating an incentive for generic producers to cluster prices around the relatively high EU price. Consequently generics can reach high unit markups.[11]

6.3 The Impact of Parallel Trade

To investigate the impact of parallel trade, I first calculate the counterfactual market equilibrium when parallel imported products are eliminated from the consumers' choice

[11] This argument is formalized by Kaiser et al. (2014).

set. Next, I compare the market outcome when parallel imports are present to the counterfactual market outcome and derive policy implications.

6.3.1 Counterfactual Market Equilibrium

Solving the system of equations in Section 5.3 yields the new market equilibrium prices and shares, which are used to find the new markups, firm profits, government expenditures and consumer expenditures. In this section I compare these results with their counterparts and summarize my findings due to parallel trade as follows.

Eliminating parallel trade reduces average prices but results in higher prices for both original products and generic products. Intuitively, average prices decrease because parallel traded products—the cheaper alternative to the original product, but relatively more expensive than the generic alternative— are removed from the market. However, as competition pressure decreases, this results in higher average prices for original products. Because prices are strategic complements, average prices for generic products increase as well. Furthermore, the copayment prices increase more for original products than for generics, which is caused by the prevailing reimbursement rules. On another dimension, prices in the off-patent sector (for original and generic products) increase more than they do in the on-patent market. This result provides evidence supporting the conjecture of Enemark et al. (2006), that parallel importers of on-patent products, where there is no generic available, do not engage in competition with original firms, because the price-sensitive market segment that will switch to parallel imports is small or the parallel importer faces capacity constraints. These results on price effects due to parallel trade are reported in Table 7.

The changes on market shares are linked to the substitution patterns. The results show that eliminating parallel trade leads to substitution from parallel imported products towards original products. Original firms benefit from a ban of parallel imports while generic firms lose market share (see Table 8). Intuitively, these substitution patterns can be attributed to the strong preferences that consumers have toward original products and because most of the parallel imported products are potentially produced by original firms, whose perceived quality is presumably closer to the original products than to the generic products. Moreover, off-patent products gain substantially on shares from a prohibition of parallel imports.

The competitive pressure from generic products is also present when parallel trade

is prohibited. Similar to the effects identified in the supply-side results, markups are lower for off-patent molecules and higher for on-patent molecules even absent parallel trade. Specifically, through the lack of competition of any kind in on-patent markets, original firms increase their markups substantially more than generic firms. The changes in markups are reported in Table 9.

Results on the impact of banning parallel trade on profits, government expenditures and consumers expenditures are presented in Table 10. Eliminating parallel trades generates an increase in profits and an increase in expenditures. The average profit for original firms in a 14-day period is DKK 0.57 million with the presence of parallel imports, this profit amounts to DKK 4.19 million after parallel imports are removed. On the contrary, the profits generated by generic firms decrease. Government expenditures and consumers expenditures follow the same path. Both, government expenditures and consumer expenditures increase substantially more for original products than for generic products.

6.3.2 Policy Implications

The results from the counterfactual analysis with respect to consumer surplus and welfare are summarized in Table 11. Eliminating parallel importers reduces consumer surplus and increases firm profits, leading to an overall decrease in welfare. Consumer surplus decreases on average by DKK 111.41 million (around $ 18.2 million or € 15 million) when parallel importers are removed from the sample.[12] The decrease in consumer surplus is driven by two effects. First, consumers face less variety of products; and because parallel imports are regarded closer substitutes to original products than generics, consumers substitute towards original products in the absence of parallel imports. Second, a less competitive environment is associated with an increase in copayment prices; in particular, consumers of original products face a higher increase in prices. Finally, total welfare is given by the sum of consumer surplus and profits. The average yearly welfare lost from a prohibition of parallel importers is on average DKK 54.9 million per year (around $ 8.9 million or € 7.37 million), a substantial decline for a market that generates around DKK 300 million per year.

Furthermore, removing parallel trade increases consumer expenditures as well as gov-

[12]The observed data covers a period of three years, but only 2004 accounts for the whole 12 months, therefore each part of the table shows the average for each year. The yearly average at the bottom is constructed for any period of 12 months.

ernment expenditures. On average, yearly government expenditures increase by DKK 182.7 million (see Table 12). Yearly consumer expenditures increase on average by DKK 75 million; a result that differs visibly from the one on consumer surplus. This shows that using only consumer expenditures as a measure of welfare, as is done in previous studies, might underestimate the total welfare loss.

7 Conclusions

This paper analyzes the effects of parallel trade in the Danish market for statins. It develops a structural model of demand and supply and uses these estimates to simulate new market outcomes under a hypothetical ban of parallel imports. There are two key results from prohibiting parallel imports. The first set focuses on price effects, which differ along two dimensions: the type of firm and the patent protection status of the molecule. Eliminating parallel trade reduces average prices but results in higher prices for both original products and generic products. Furthermore, average prices for off-patent products decrease, while average prices for on-patent products are positively affected by excluding parallel imports. The second set of results reports the effects on market participants: Firms, government and consumers. On average, firms profits increase, but the effect is positive for original firms and negative for generic firms. Consumer surplus decreases due to a decrease in variety and an increase in expenditures. Moreover, government expenditures increase due to a prohibition of parallel trade. Finally, total welfare is defined as the sum of consumer surplus and profits. Eliminating parallel trade leads to an overall decrease in welfare.

My model takes into consideration consumers' preferences that determine substitution patterns in the measure of consumer surplus, as opposed to previous studies that use only consumers expenditures as a welfare measure. My results support the view that parallel trade generates significant savings to consumers and insurers. Furthermore, the analysis carefully follows the rules and regulation in Denmark. To expand these results to other geographical markets, albeit not difficult, it is necessary to consider local regulation rules, which play an important role in determining the results.

Finally, while beyond the scope of this paper, the long-term effects of parallel trade, particularly on incentives to innovate, remain a highly controversial and unresolved question. Because innovation is an important driver of consumer welfare, the subject consti-

tutes an important issue for further research.

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Tables

Table 1: **Danish Market for Statins**

ATC Code	Molecule	Brand name	Original Firm	Obs.	Average Number of	
					Firms	Products
C10AA01	Simvastatin	Zocor	*MSD Sharp & Dohme*	3,323	11.85	69.51
					(1.02)	(10.85)
C10AA02	Lovastatin	Mevacor	*MSD Sharp & Dohme*	829	5.39	17.44
					(0.81)	(2.72)
C10AA03	Pravastatin	Pravachol	*Bristol-Myers Squibb*	766	5.94	19.28
					(2.06)	(8.13)
C10AA04	Fluvastatin	Lescol	*Novartis*	490	2.00	10.00
					(0.00)	(0.00)
C10AA05	Atorvastatin	Lipitor	*Pfizer*	611	3.03	12.57
					(0.44)	(1.11)
C10AA07	Rosuvastatin	Crestor	*AstraZeneca*	369	1.59	8.10
					(0.75)	(1.37)
All molecules				6,388	19.71	130.76
					(1.96)	(7.05)

Notes: Average number of firms and average number of products in each molecule group for a 14-days period. Products are characterized by the combination of molecule (5-level ATC code), strength, package size and firm. Standard deviation in parentheses

Table 2: **Average Prices**

	Pharmacy Purchase Price (p^f)	Reference Price (p^r)	Copayment Price (p^{cop})
A. *All Products*			
	5.93	7.31	3.21
	(4.53)	(5.34)	(4.42)
B. *By ATC Code*			
C10AA01	4.63	4.42	3.76
	(4.94)	(3.91)	(5.77)
C10AA02	7.08	9.16	3.47
	(3.78)	(4.30)	(3.04)
C10AA03	7.71	11.10	2.57
	(4.41)	(6.20)	(1.81)
C10AA04	8.27	12.66	2.56
	(2.14)	(3.56)	(0.72)
C10AA05	7.91	11.53	2.31
	(2.99)	(4.50)	(0.90)
C10AA07	4.92	7.19	1.44
	(1.35)	(2.05)	(0.41)
C. *By Firm Type*			
Original Firm	8.68	10.35	4.63
	(3.62)	(4.91)	(4.84)
Generic Firm	2.62	3.86	1.31
	(2.03)	(2.32)	(1.77)
Parallel Importer	7.64	8.92	4.4
	(5.04)	(6.07)	(5.50)
D. *By Patent Status*			
Off-Patent	5.69	6.67	3.46
	(4.78)	(5.31)	(4.82)
On-Patent	7.00	10.29	2.06
	(2.85)	(4.34)	(0.87)

Notes: Fortnightly average prices for a defined daily dose in Danish krones. All figures deflated using consumer prices index with June 2005 as basis. p^f is the pharmacy purchase price, p^r is the reference price, and $p^{cop} = p^c - 0.8 * p^r$ is the copayment price. The results are summarized as follows: A. All products, B. Products in the same ATC code, C. Products from the same firm type, and D. Products on-patent and off-patent. Exchange rates in June 2005: DKK 1 = $ 0.1634 = € 0.1343. Standard deviation in parentheses.

Table 3: **Average Sales, Average Revenues, and Average Expenditures**

	Sales	Revenues	Expenditures	
			Government	Consumers
A. *All Products*				
	2,446.127	9.139	10.342	3.315
	(520.621)	(1.891)	(2.075)	(0.627)
B. *By ATC Code*				
C10AA01	1,669.324	2.516	2.729	1.344
	(550.280)	(0.498)	(0.579)	(0.224)
C10AA02	24.420	0.186	0.188	0.087
	(4.845)	(0.103)	(0.123)	(0.037)
C10AA03	182.748	1.554	1.776	0.472
	(45.749)	(0.803)	(0.951)	(0.202)
C10AA04	23.021	0.178	0.211	0.053
	(4.910)	(0.041)	(0.049)	(0.012)
C10AA05	470.609	4.312	4.982	1.246
	(76.914)	(0.897)	(1.052)	(0.263)
C10AA07	79.241	0.409	0.477	0.119
	(33.288)	(0.166)	(0.191)	(0.048)
C. *By Firm Type*				
Original Firms	694.424	6.176	6.615	2.325
	(167.741)	(1.793)	(2.018)	(0.593)
Generic Firms	1,498.947	1.639	2.182	0.584
	(633.574)	(0.527)	(0.691)	(0.176)
Parallel Imports	252.757	1.324	1.545	0.406
	(149.244)	(0.100)	(0.444)	(0.141)
D. *By Patent Status*				
Off-Patent	1,890.991	4.367	4.823	1.935
	(525.779)	(1.165)	(1.238)	(0.411)
On-Patent	555.136	4.772	5.519	1.380
	(72.161)	(0.868)	(1.020)	(0.255)

Notes: Sales are fortnightly averages in 1,000 defined daily dosages. Revenues and expenditures are fortnightly averages in million Danish krones. The results are summarized as follows: A. All products, B. Products in the same ATC code, C. Products from the same firm type, and D. Products on-patent and off-patent. Exchange rates in June 2005: DKK 1 = $ 0.1634 = € 0.1343. Standard deviation in parentheses.

Table 4: **Demand Estimation**

	OLS - Nested Logit		IV - Nested Logit	
	Coef.	Std. Error	Coef.	Std. Error
Copayment price	-0.053***	(0.004)	-0.831***	(0.051)
Conditional share	0.880***	(0.007)	0.315*	(0.123)
Strength in ddd	0.347***	(0.022)	-0.807***	(0.067)
Package size	0.024***	(0.0004)	0.018***	(0.001)
On-Patent	0.979***	(0.064)	1.697***	(0.119)
No. prod. in nest	0.239***	(0.005)	-0.212***	(0.051)
Constant	-11.416***	(0.609)	-10.669***	(0.952)
Firm Dummy Variables				
Original Firms				
AstraZeneca	0.589	(0.609)	2.813**	(0.939)
Bristol-Myers Squibb	2.601***	(0.611)	6.183***	(0.957)
MSD Sharp & Dohme	1.897**	(0.609)	9.207***	(1.036)
Novartis	0.415	(0.610)	2.244*	(0.940)
Pfizer	2.147***	(0.611)	5.056***	(0.947)
Generic Firms				
1A Farma	1.768**	(0.611)	2.614*	(1.024)
Actavis	0.21	(0.612)	0.742	(0.937)
Alpharma	2.186***	(0.610)	2.084*	(0.942)
Alternova	1.401*	(0.608)	1.336	(0.934)
Arrow	1.002	(0.632)	4.330***	(0.947)
Durascan	1.987**	(0.609)	0.663	(0.952)
Genthon	1.283*	(0.617)	1.066	(0.971)
Gevita	1.702**	(0.612)	0.634	(0.956)
Hexal	2.052***	(0.609)	2.143*	(0.947)
Ranbaxy	1.186	(0.620)	0.915	(0.964)
Ratiopharm	1.198*	(0.609)	0.349	(0.959)
Sandoz	1.270*	(0.611)	-0.073	(0.970)
Parallel Importers				
Copyfarm	2.013**	(0.622)	0.618	(0.984)
EuroPharma	1.261*	(0.616)	1.941	(0.998)
Orifarm	1.454*	(0.609)	4.207***	(0.968)
Paranova	1.230*	(0.609)	2.237*	(0.964)
PharmaCoDane	1.411*	(0.608)	4.729***	(1.065)
Recept Pharma	1.230*	(0.621)	1.138	(0.957)
Stada	0.082	(0.612)	0.522	(0.979)

Notes: Table 4 reports OLS and IV - nested logit estimates of equation (5). The dependent variable is $ln(s_j) - ln(s_o)$. The number of observations is 6,388. The specification also includes firm, and time period dummy variables. The reference category for firm dummy variables is the parallel importer *Universal Pharma*. Robust standard errors in parenthesis. ***, ** and * indicate statistical significance at the one, five, and ten percent level. The instruments for the IV - nested logit are: the number of products of rival firms, average price of products from the same firm in other substitution groups, the sum of characteristics of rival firms, and squares of own products' characteristics. The first stage F-test statistics for instruments significance are: 36.40 (p-value 0.00) for *Copayment price* and 26.57 (p-value 0.00) for *Conditional share*.

Table 5: **Average Own- and Cross-Price Elasticities of Demand**

	Own-price elasticities	Cross-price elasticities	
		Same nest	Different nest
A. *All Products*			
	-3.608	0.179	0.0014
	(5.263)	(0.245)	(0.0004)
B. *By ATC Code*			
C10AA01	-4.398	0.074	0.0015
	(6.878)	(0.193)	(0.0004)
C10AA02	-3.816	0.359	0.0014
	(3.380)	(0.268)	(0.0003)
C10AA03	-2.854	0.191	0.0013
	(2.077)	(0.137)	(0.0003)
C10AA04	-2.559	0.536	0.0014
	(0.845)	(0.222)	(0.0004)
C10AA05	-2.190	0.256	0.0014
	(0.732)	(0.132)	(0.0003)
C10AA07	-1.325	0.272	0.0014
	(0.412)	(0.188)	(0.0003)
C. *By Firm Type*			
Original Firm	-5.043	0.273	0.0014
	(5.906)	(0.259)	(0.0004)
Generic Firm	-1.542	0.101	0.0014
	(2.150)	(0.139)	(0.0004)
Parallel Importer	-5.016	0.230	0.0015
	(6.558)	(0.317)	(0.0004)
D. *By Patent Status*			
Off-patent	-3.962	0.162	0.0015
	(5.727)	(0.245)	(0.0004)
On-patent	-1.959	0.316	0.0014
	(0.806)	(0.200)	(0.0004)

Notes: Table 5 reports mean own and cross-price elasticities of demand using the results from the IV - nested logit. The results are summarized as follows: A. All products, B. Products in the same ATC code, C. Products from the same firm type, and D. Products on-patent and off-patent. Standard deviation in parentheses.

Table 6: **Average Marginal Cost and Average Markups**

	Marginal Cost	Marginal Cost in %	Markups	Markups in %
A. *All Products*				
	5.277	79.082	0.648	20.918
	(4.486)	(19.084)	(0.137)	(19.084)
B. *By ATC Code*				
C10AA01	4.038	71.886	0.588	28.114
	(4.906)	(22.991)	(0.135)	(22.991)
C10AA02	6.428	87.015	0.651	12.985
	(3.760)	(8.056)	(0.074)	(8.056)
C10AA03	7.052	85.888	0.655	14.112
	(4.395)	(11.498)	(0.087)	(11.498)
C10AA04	7.537	90.279	0.732	9.721
	(2.184)	(3.690)	(0.076)	(3.690)
C10AA05	7.141	88.423	0.774	11.577
	(2.957)	(5.995)	(0.110)	(5.995)
C10AA07	4.080	81.603	0.840	18.397
	(1.324)	(5.183)	(0.058)	(5.183)
C. *By Firm Type*				
Original Firm	7.940	88.943	0.745	11.057
	(3.673)	(7.351)	(0.114)	(7.351)
Generic Firm	2.035	68.068	0.584	31.932
	(2.002)	(21.100)	(0.125)	(21.100)
Parallel Importer	7.014	84.038	0.631	15.962
	(4.992)	(16.904)	(0.114)	(16.904)
D. *By Patent Status and Firm Type*				
Off-Patent	5.077	77.496	0.617	22.504
	(4.740)	(20.476)	(0.125)	(20.476)
Original Firm	9.211	91.331	0.687	8.669
	(3.567)	(6.856)	(0.100)	(6.856)
Generic Firm	2.035	68.068	0.584	31.932
	(2.002)	(21.100)	(0.125)	(21.100)
Parallel Importer	7.200	83.298	0.623	16.702
	(5.321)	(18.016)	(0.118)	(18.016)
On-Patent	6.208	86.465	0.789	13.535
	(2.855)	(6.465)	(0.099)	(6.465)
Original Firm	6.304	85.869	0.819	14.131
	(3.119)	(6.809)	(0.083)	(6.809)
Parallel Importer	5.855	88.652	0.679	11.348
	(1.495)	(4.362)	(0.073)	(4.362)

Notes: Table 6 reports average marginal cost and markups calculated from the first order conditions in equation (7) in Danish krones per defined daily dose and marginal cost and markups as percentage of pharmacy purchase prices. The results are summarized as follows: A. All products, B. Products in the same ATC code, C. Products from the same firm type, and D. Products on-patent and off-patent. Exchange rates in June 2005: DKK 1 = $ 0.1634 = €0.1343. Standard deviation in parentheses

Table 7: **Average Change in Prices**

	Pharmacy purchase price (p^f)			Reference price (p^r)			Copayment price (p^{cop})		
	real	counter.	change in %	real	counter.	change in %	real	counter.	change in %
A. *All Products*									
	5.92	5.33	-10.08	7.31	6.70	-8.37	3.21	2.84	-11.50
	(4.53)	(4.17)		(5.34)	(4.88)		(4.42)	(3.93)	
B. *By ATC Code*									
C10AA01	4.63	3.70	-19.96	4.42	3.69	-16.71	3.76	2.99	-20.58
	(4.94)	(4.03)		(3.91)	(2.29)		(5.77)	(4.99)	
C10AA02	7.08	6.70	-5.41	9.16	8.09	-11.62	3.47	3.83	10.60
	(3.78)	(4.14)		(4.30)	(4.03)		(3.04)	(3.68)	
C10AA03	7.71	6.56	-14.92	11.10	9.13	-17.69	2.57	2.46	-4.19
	(4.41)	(4.27)		(6.20)	(5.66)		(1.81)	(2.13)	
C10AA04	8.27	8.27	0.01	12.66	12.65	-0.07	2.56	2.57	0.32
	(2.14)	(2.14)		(3.56)	(3.56)		(0.72)	(0.72)	
C10AA05	7.91	8.54	7.90	11.53	12.41	7.72	2.31	2.56	10.66
	(2.99)	(3.49)		(4.50)	(5.29)		(0.90)	(1.04)	
C10AA07	4.92	5.04	2.47	7.19	7.37	2.41	1.44	1.49	3.27
	(1.35)	(1.30)		(2.05)	(2.00)		(0.41)	(0.39)	
C. *By Firm Type*									
Original Firm	8.69	8.79	2.49	10.35	10.34	0.15	4.63	4.79	3.45
	(3.62)	(3.63)		(4.91)	(4.90)		(4.84)	(4.94)	
Generic Firm	2.62	2.63	3.55	3.86	3.86	1.54	1.31	1.33	2.84
	(2.03)	(2.01)		(2.32)	(2.28)		(1.77)	(1.78)	
Parallel Importer	7.64			8.92			4.40		
	(5.04)			(6.07)			(5.50)		
D. *By Patent Status and Firm Type*									
Off-Patent	5.69	4.90	-14.01	6.67	5.79	-13.16	3.46	3.01	-13.04
	(4.78)	(4.27)		(5.31)	(4.45)		(4.82)	(4.33)	
Original Firm	9.90	10.07	4.09	10.22	10.20	0.28	6.59	6.85	11.32
	(3.52)	(3.49)		(5.04)	(5.02)		(5.67)	(5.75)	
Generic Firm	2.62	2.63	3.55	3.86	3.86	1.54	1.31	1.33	2.84
	(2.03)	(2.01)		(2.32)	(2.28)		(1.77)	(1.78)	
Parallel Importer	7.82			8.84			4.80		
	(5.37)			(6.48)			(5.82)		
On-Patent	7.00	7.15	2.16	10.29	10.52	2.27	2.06	2.14	4.05
	(2.85)	(3.11)		(4.34)	(4.74)		(0.87)	(0.95)	
Original Firm	7.12	7.15	0.43	10.53	10.52	-0.03	2.11	2.14	2.22
	(3.11)	(3.11)		(4.74)	(4.74)		(0.95)	(0.95)	
Parallel Importer	6.53			9.42			1.90		
	(1.49)			(2.16)			(0.44)		

Notes: Fortnightly average prices for a defined daily dose in Danish krones and average percentage change. All figures deflated using consumer prices index with June 2005 as basis. The results are summarized as follows: A. All products, B. Products in the same ATC code, C. Products from the same firm type, and D. Products on-patent and off-patent. Exchange rates in June 2005: DKK 1 = $ 0.1634 = € 0.1343. Standard deviation in parentheses

Table 8: **Average Change in Shares**

	Real	Counterfactual	Change in %
A. *All Products*			
	0.124	0.243	96.337
	(0.429)	(1.539)	
B. *By ATC Code*			
C10AA01	0.161	0.355	120.109
	(0.567)	(2.103)	
C10AA02	0.010	0.168	1621.355
	(0.014)	(0.637)	
C10AA03	0.079	0.086	8.888
	(0.176)	(0.148)	
C10AA04	0.016	0.019	21.171
	(0.015)	(0.030)	
C10AA05	0.254	0.283	11.385
	(0.284)	(0.268)	
C10AA07	0.066	0.063	-3.295
	(0.044)	(0.059)	
C. *By Firm Type*			
Original Firm	0.113	0.481	324.499
	(0.214)	(2.299)	
Generic Firm	0.184	0.058	-68.189
	(0.625)	(0.137)	
Parallel Importer	0.048		
	(0.165)		
C. *By Patent Status*			
Off-Patent	0.116	0.264	127.819
	(0.460)	(1.708)	
On-Patent	0.161	0.156	-3.295
	(0.234)	(0.215)	

Notes: Fortnightly average shares per product in percentage. The results are summarized as follows: A. All products, B. Products in the same ATC code, C. Products from the same firm type, and D. Products on-patent and off-patent. Standard deviation in parentheses.

Table 9: **Average Change in Markups**

	Real	Counterfactual	Change in %
A. *All Products*			
	0.648	0.706	9.031
	(0.137)	(0.215)	
B. *By ATC Code*			
C10AA01	0.589	0.645	9.567
	(0.135)	(0.241)	
C10AA02	0.651	0.741	13.875
	(0.074)	(0.256)	
C10AA03	0.655	0.699	6.713
	(0.087)	(0.119)	
C10AA04	0.732	0.733	0.109
	(0.076)	(0.079)	
C10AA05	0.774	0.875	13.148
	(0.110)	(0.010)	
C10AA07	0.840	0.859	2.226
	(0.058)	(0.004)	
C. *By Firm Type*			
Original Firm	0.745	0.852	14.336
	(0.114)	(0.255)	
Generic Firm	0.584	0.593	1.576
	(0.125)	(0.049)	
Parallel Importer	0.631		
	(0.114)		
D. *By Patent Status*			
Off-Patent	0.617	0.674	9.103
	(0.125)	(0.225)	
On-Patent	0.789	0.844	6.968
	(0.099)	(0.061)	

Notes: Table 9 reports average markups per defined daily dose in Danish krones. The results are summarized as follows: A. All products, B. Products in the same ATC code, C. Products from the same firm type, and D. Products on-patent and off-patent. Standard deviation in parentheses.

Table 10: **Changes in Profits and Expenditures**

	Variable Profits			Government Expenditures			Consumer Expenditures		
	real	counter.	change in %	real	counter.	change in %	real	counter.	change in %
A. *All Products*									
	1.54	4.48	189.84	10.34	18.48	78.70	3.32	7.04	112.29
	(0.41)	(6.59)		(2.08)	(7.23)		(0.63)	(5.58)	
B. *By ATC Code*									
C10AA01	0.91	3.75	312.10	2.73	9.62	252.40	1.34	4.51	235.42
	(0.42)	(6.78)		(0.58)	(8.18)		(0.22)	(6.18)	
C10AA02	0.02	0.25	1,365.12	0.19	3.38	1,700.00	0.09	1.10	1,173.99
	(0.00)	(0.41)		(0.12)	(5.88)		(0.04)	(1.53)	
C10AA03	0.14	0.10	-31.52	1.78	1.32	-25.94	0.47	0.35	-25.41
	(0.04)	(0.06)		(0.95)	(0.92)		(0.20)	(0.24)	
C10AA04	0.02	0.02	14.94	0.21	0.25	20.55	0.05	0.06	20.98
	(0.00)	(0.02)		(0.05)	(0.25)		(0.01)	(0.06)	
C10AA05	0.39	0.30	-23.47	4.98	3.47	-30.28	1.25	0.90	-27.66
	(0.07)	(0.15)		(1.05)	(1.66)		(0.26)	(0.43)	
C10AA07	0.07	0.06	-8.96	0.48	0.47	-2.08	0.12	0.12	-1.85
	(0.03)	(0.03)		(0.19)	(0.25)		(0.05)	(0.06)	
C. *By Firm Type*									
Original Firm	0.57	4.19	633.50	6.61	17.50	164.55	2.32	6.78	191.47
	(0.14)	(6.67)		(2.02)	(7.36)		(0.59)	(5.65)	
Generic Firm	0.81	0.29	-64.44	2.18	0.98	-55.05	0.58	0.26	-55.14
	(0.43)	(0.14)		(0.69)	(0.40)		(0.18)	(0.12)	
Parallel Importer	0.17			1.54			0.41		
	(0.10)			(0.53)			(0.14)		
D. *By Patent Status*									
Off-Patent	1.08	4.11	279.95	4.82	14.41	198.77	1.94	5.99	209.36
	(0.41)	(6.67)		(1.24)	(8.03)		(0.41)	(5.83)	
On-Patent	0.46	0.37	-19.81	5.52	4.07	-26.18	1.38	1.05	-23.76
	(0.06)	(0.18)		(1.02)	(1.90)		(0.26)	(0.49)	

Notes: Total variable profits, total government expenditures and total consumer expenditures are fortnightly average in million Danish krones. The results are summarized as follows: A. All products, B. Products in the same ATC code, C. Products from the same firm type, and D. Products on-patent and off-patent. Exchange rates in June 2005: DKK 1 = $ 0.1634 = €0.1343. Standard deviation in parentheses

Table 11: **Average Welfare Effects**

	real	counterfactual	change	change in %
A. *Consumer Surplus*				
May 2003 - Dec. 2003	120.32	56.37	-63.95	-53.15
Jan. 2004 - Dec. 2004	365.55	188.27	-177.28	-48.50
Jan. 2005 - Mar. 2005	28.95	16.85	-12.11	-41.81
Yearly average	232.35	119.78	-111.41	-49.29
B. *Variable Profits*				
May 2003 - Dec. 2003	21.67	36.50	14.83	71.44
Jan. 2004 - Dec. 2004	47.32	171.68	124.37	251.41
Jan. 2005 - Mar. 2005	6.69	11.15	4.47	76.08
Yearly average	38.03	94.54	56.51	167.50
C. *Total Welfare*				
May 2003 - Dec. 2003	141.99	92.87	-49.11	-34.59
Jan. 2004 - Dec. 2004	412.87	359.96	-52.91	-12.82
Jan. 2005 - Mar. 2005	35.64	28.00	-7.64	-21.43
Yearly average	270.38	214.32	-54.90	-20.73

Notes: All figures are in million Danish krones. Exchange rates in June 2005: DKK 1 = $ 0.1634 = € 0.1343. The average yearly difference in consumer surplus is -111.41 million Danish krones. The average yearly difference in variable profits is 56.51 million Danish krones

Table 12: **Average Yearly Expenditures**

	real	counterfactual	change	change in %
A. *Government Expenditures*				
May 2003 - Dec. 2003	207.23	330.43	123.20	62.45
Jan. 2004 - Dec. 2004	251.24	507.05	255.81	101.96
Jan. 2005 - Mar. 2005	48.27	68.10	19.83	41.95
Yearly average	271.51	454.22	182.71	80.90
B. Consumers Expenditures				
May 2003 - Dec. 2003	65.92	97.10	31.17	48.28
Jan. 2004 - Dec. 2004	80.76	225.74	144.98	190.85
Jan. 2005 - Mar. 2005	15.76	22.04	6.28	41.14
Yearly average	87.29	162.29	75.00	123.06

Notes: All figures are in million Danish krones. Exchange rates in June 2005: DKK 1 = $ 0.1634 = € 0.1343.

A From pharmacy purchase price to pharmacy retail price

Using the information in the table below, the pharmacy retail price including VAT (25%) and fees for a product in the most expensive category before June 2003 is: $p^c = 1.25 * (6.15 + 0.601 * (0.2 * p^f + 19.8) + p^f)$.

BEK nr. 133	Mar. 14 2003 Jun. 09 2003	From the pharmacy purchase price per package pay 60.1% of the following amounts: if $p^f \leq$ DKK 30 : 60% of p^f + DKK 1.80 if DKK 30 $< p^f \leq$ DKK 60: 40% of p^f + DKK 7.80 if $p^f >$ DKK 60: 20% of p^f + DKK 19.80 Prescription's fee excl. VAT: DKK 6.15.
BEK nr. 368	Jun. 09 2003 Mar. 26 2004	From the pharmacy purchase price per package pay 64.1% of the following amounts: if $p^f \leq$ DKK 30 : 60% of p^f + DKK 1.80 if DKK 30 $< p^f \leq$ DKK 60: 40% of p^f + DKK 7.80 if $p^f >$ DKK 60: 20% of p^f + DKK 19.80 Prescription's fee excl. VAT: DKK 6.15.
BEK nr. 270	Mar. 26 2004 Apr. 12 2004	From the pharmacy purchase price per package pay 61% of the following amounts: if $p^f \leq$ DKK 30 : 60% of p^f + DKK 1.80 if DKK 30 $< p^f \leq$ DKK 60: 40% of p^f + DKK 7.80 if $p^f >$ DKK 60: 20% of p^f + DKK 19.80 Prescription's fee excl. VAT: DKK 6.15.
BEK nr. 231	Apr. 12 2004 Feb. 28 2005	From the pharmacy purchase price per package pay 64.3% of the following amounts: if $p^f \leq$ DKK 30 : 60% of p^f + DKK 1.80 if DKK 30 $< p^f \leq$ DKK 60: 40% of p^f + DKK 7.80 if $p^f >$ DKK 60: 20% of p^f + DKK 19.80 Prescription's fee excl. VAT: DKK 6.15.
BEK nr. 123	Feb. 28 2005 Apr. 01 2005	From the pharmacy purchase price per package pay 59.4% of the following amounts: if $p^f \leq$ DKK 30 : 60% of p^f + DKK 1.80 if DKK 30 $< p^f \leq$ DKK 60: 40% of p^f + DKK 7.80 if $p^f >$ DKK 60: 20% of p^f + DKK 19.80 Prescription's fee excl. VAT: DKK 6.15.
BEK nr. 122	Apr. 01 2005 Jul. 18 2005	From the pharmacy purchase price per package pay 59.4% of the following amounts: if $p^f \leq$ DKK 30 : 44.6% of p^f + DKK 8.29 if DKK 30 $< p^f \leq$ DKK 60: 31.3% of p^f + DKK 12.29 if $p^f >$ DKK 60: 18% of p^f + DKK 20.29 Prescription's fee excl. VAT: DKK 6.76.

Notes: These rules and regulations can be found under: *www.retsinformation.dk*