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Abstract

We study the impact of product margins on pharmacies' incentive to promote generics instead of brand-names. First, we construct a theoretical model where pharmacies can persuade patients with a brand-name prescription to purchase a generic version instead. We show that pharmacies' substitution incentives are determined by relative margins and relative patient copayments. Second, we exploit a unique product level panel data set, which contains information on sales and prices at both producer and retail level. In the empirical analysis, we find a strong relationship between the margins of brand-names and generics and their market shares. This relationship is stronger for pharmaceuticals under reference pricing rather than coinsurance. In terms of policy implications, our results suggest that pharmacy incentives are crucial for promoting generic sales.

JEL-Code: I110, I180, L130, L650.

Keywords: pharmaceuticals, pharmacies, generic substitution.

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1 Introduction

In this paper we study pharmacies' role in promoting generic substitution and thus competition between brand-names and generics. Most consumers enter the pharmacy with a prescription of a brand-name product due to the tendency of physicians to prescribe brand-names rather than the cheaper, but therapeutically equivalent, generic versions. Insurers (payers) therefore use various instruments to increase competition and generic market shares in order to reduce pharmaceutical expenditures. One important instrument is generic substitution regulation, which implies that pharmacies can dispense a generic substitute to consumers with a brand-name prescription. However, convincing consumers that a generic product is of the same quality (therapeutically equivalent) as the brand-name product prescribed by the physician is likely to involve costly promotional effort by the pharmacies, so what are the incentives for pharmacies to engage in generic substitution?

The obvious answer is the pharmacies' profitability of selling generics rather than brand-names. We therefore study the role of pharmacies in promoting generic sales by analysing the relationship between the margins that pharmacies obtain for brand-names and generics and their respective market shares. We find this issue interesting for several reasons. First, pharmaceutical expenditures are growing in most Western countries, and the off-patent market is becoming increasingly important as patents have expired for several blockbusters.[1] Stimulating generic competition is therefore seen as one of the most important instruments for regulators (payers) to contain costs in this industry.

Second, our paper is, to the best of our knowledge, the first to study the role of pharmacies in promoting generic sales and the effect of generic substitution regulation. There are several papers on the physicians' prescription choice between brand-names and generics.[2] There are also

[1] See, for instance, the reports by Pharma (2008) and EGA (2009). According to EGA (2009) about half of the dispensed pharmaceuticals in the off-patent market segment in the European Union are generics, but there are large variations across the member countries. In the US, however, the generic market share (in volume) in this segment is about 90 percent. Thus, there should be great scope for regulatory policies to affect the generic sales and thus the pharmaceutical expenditures.

[2] Hellerstein (1998) uses US survey data and finds that physician characteristics (not patient characteristics) explain why patients are prescribed a brand-name or a generic. Coscelli (2000) uses Italian microdata on prescriptions and finds evidence for habit persistence for both physicians and patients. Finally, Lundin (2000) finds that patients facing large copayments are less (more) likely to receive a brand-name (generic) prescription using Swedish microdata.

a few, recent papers on the physicians' choice of drug when they are allowed to dispense drugs and can pocket the product margin.[3] There is also a large literature on the impact of regulation and copayment schemes on generic sales, where recent studies show that reference pricing, which imposes extra copayments on patients that demand high-priced brand-names, tends to promote generic sales and reduce prices and expenditures.[4] None of these studies consider the role of pharmacies in stimulating generic sales.

Finally, our study offers insight into retailer incentives more broadly, as we study the promotional incentives for steering consumers toward more profitable products. The idea that retailers can influence consumers' purchase choices among competing products, and that their incentives to do so depend on relative margins, goes back at least as far as Telser (1960).[5] Similar incentives are likely to be present in many downstream markets, where retailers sell rival products (e.g., grocery stores, electronic stores, car dealers, etc.), not just in the pharmaceutical market.[6]

We study the pharmacies' incentives for generic substitution both theoretically and empirically. In the theoretical part, we set up a vertical differentiation model where brand-names are perceived to be of higher quality than their generic versions. Within this framework we introduce a (monopoly) pharmacy that may expend effort on persuading consumers to buy a generic version, for instance, by informing them that the products are therapeutically equivalent.[7] We analyse the pharmacy's substitution incentives under different copayment schemes (i.e., coinsurance and reference pricing) and pricing regimes (i.e., prices are regulated or set by the pharmacy).

[3] Iizuka (2007) studies prescription choices in Japan where physicians also can dispense drugs and pocket the (regulated) margin. He finds that physicians tend to prescribe drugs with higher margins, but they are also concerned about the copayments of their patients. Liu et al. (2009) study the same phenonomen in Taiwan.

[4] Pavcnik (2002) studies the introduction of reference pricing in Germany in 1989, and reports significant price reductions on both brand-names and generics. Brekke et al. (2009, 2011) exploit a policy experiment in Norway, and report large reductions in prices and brand-name market shares, resulting in lower total expenditures and copayments. See also Aronsson et al. (2001) and Bergman and Rudholm (2003) for similar results in Sweden.

[5] A recent paper considering such "steering" by retailers is Raskovich (2007), who shows that competition for steering by upstream suppliers can lead to double-marginalisation.

[6] A well known argument in the IO literature for common agency is that it facilitates collusion in the downstream market and is therefore in the interest also of upstream suppliers (Bernheim and Whinston, 1985, 1986). On the other hand, the retailer's ability to steer demand towards more profitable products can induce more competition between suppliers and create a rationale for exclusive dealing. However, the question of common agency versus exclusive dealing is less of an issue in our setting since such contracts are strictly regulated requiring pharmacies to store and deliver the full range of pharmaceuticals that are prescribed.

[7] In some countries or health plans, generic substitution is mandatory. However, patients can still refuse to accept a generic version, which means that persuasion still plays a role also under mandatory generic substitution.

The theoretical analysis offers three main findings. First, we show that the pharmacy's incentive for generic substitution is higher (i) the larger the generic margin is relative to the brand-name margin, and (ii) the lower the generic copayment is relative to the brand-name copayment. If the brand-name margin is higher than the generic margin, the pharmacy has no incentives to expend effort on generic substitution. Moreover, if the brand-name copayment is equal to (or even lower than) the generic copayment, the pharmacy would not be able to convince patients to substitute the prescribed brand-name with a generic version.

Second, we show that pharmacy price setting involves counteracting effects on the generic substitution effort. A lower, say, brand-name price implies a lower brand-name margin, which increases the generic substitution effort. However, a lower brand-name price also implies a lower copayment difference, which makes consumers less willing to accept a generic substitute. Optimal pharmacy pricing balances these two considerations.

Finally, we show that reference pricing gives stronger incentives for generic substitution effort than regular coinsurance provided that the distribution of consumers' willingness-to-pay is characterised by either an increasing or a sufficiently weakly decreasing density function. The reason is that reference pricing induces larger copayment differences between brand-names and generics, and therefore higher financial gains for consumers purchasing generics, which implies that substitution effort by the pharmacy is more effective. This result holds irrespective of whether prices are regulated or set by the pharmacy.

Based on the theoretical analysis, we derive two testable predictions: (i) a larger difference between generic and brand-name margins increases the generic market share; (ii) this effect is stronger in therapeutic markets where drugs are subject to reference pricing. In the empirical part, we test these two predictions using a unique product-level data set with detailed information on all prescription-bound sales in Norway. Our data set is generated by merging two public register databases from the Norwegian Institute of Public Health containing sales information at pharmacy level (the Prescription database) and at producer level (the Wholesale database). The databases are merged by using wholesaler-pharmacy ownership information, which allows us to compute the product margin for brand-names and generics.[8] Our data set covers 70 off-patent

[8] Since most pharmacies (more than 85 percent) in the Norwegian market are vertically integrated with (owned

substances, where brand-names face competition from generic versions, over a four-year period from 2004 to 2008.

The descriptive statistics show that brand-names are on average priced higher than generics both at pharmacy and producer level.[9] However, the average brand-name margin is much lower than the average generic margin, suggesting that pharmacies have a financial incentive to engage in generic substitution. We test the relationship between relative product margins and market shares using fixed effects for substitution groups[10] and wholesaler (pharmacy chain). Since price changes at pharmacy (retail) level affects both margins and demand (through the change in copayments), we control for the pharmacy price differences of brand-names and generics. This implies that the effect of product margins on market shares is identified by exogenous variation in the branded-generic producer price difference.

We find a highly significant effect of relative brand-name and generic product margins on market shares. The result confirms our first prediction that a larger difference between generic and brand-name margins increases the generic market share due to pharmacies substitution effort. We also find that the effect is stronger for pharmaceuticals subject to reference pricing rather than regular coinsurance, which suggests that pharmacy substitution effort is more effective when the copayment difference is larger. This result is consistent with our second prediction. We check the robustness of our results in various ways. One issue is endogeneity in pharmacy pricing as a response to changes in producer prices. We deal with this by using Danish pharmacy prices as instruments, and show that the results are qualitatively the same.

In terms of policy implications, our analysis highlights the importance of taking pharmacy incentives into account when designing the optimal regulatory scheme for the pharmaceutical industry. Since brand-names are generally priced higher than their generic versions, regressive mark-up regulation at pharmacy level is a necessary and powerful regulatory instrument to incentives generic sales at pharmacy level. However, pharmacy incentives needs to be matched

by) three different wholesalers, we compute the joint wholesaler-pharmacy product margin.

[9] Consistent with previous studies, we also observe that higher priced brand-names maintain fairly large market shares despite facing competition from lower priced generic versions that are therapeutically equivalent drugs (see, e.g., Grabowski and Vernon, 1992, Frank and Salkever, 1997, Pavcnik, 2002, Brekke et al., 2009, 2011).

[10] Substitution groups are defined by the regulator (Norwegian Medicines Agency) and specify the set of products that pharmacies can substitute. This is typically generic products with same substance, strength and presentation form as the brand-name.

with an appropriate copayment scheme where patient financially benefit from purchasing generic versions. Our results show that reference pricing provides stronger incentives than regular coinsurance for pharmacies to promote generic products. Thus, when taking pharmacy incentives into account, the cost-saving effect of reference pricing might be even higher than previously thought.

The rest of the paper is organised as follows. In Section 2 we present a theoretical model of pharmacy incentives and derive some key results regarding the relationship between margins and market shares for brand-name and generic drugs. Section 3 describes the institutional background and the Norwegian pharmaceutical market. In Section 4 we present data and descriptive statistics, while Section 5 describes our empirical method and results. In Section 6 we briefly discuss policy implications before the paper is concluded in Section 7.

2 A theoretical model of pharmacy incentives

There is a total mass of 1 consumers, each with a prescription for the same brand-name drug that is dispensed by a pharmacy. There is also a generic copy-drug available in case the consumer wants to substitute. Consumers differ in their willingness-to-pay for drugs. The net utility of drug consumption is given by

$$U = \begin{cases} v - c_b & if \quad \text{brand-name} \\ \theta v - c_g & if \quad \text{generic} \end{cases}, \tag{1}$$

where v is distributed on $[\underline{v}, \overline{v}]$ with a density function $f(v)$ and a corresponding cumulative distribution function $F(v) = \int_{\underline{v}}^{v} f(x)\,dx$. The parameter $\theta \in (0,1)$ represents the quality degradation that consumers attribute to the generic version of the drug, while c_b and c_g are the copayments of the brand-name and generic drug, respectively. We assume that $\underline{v} > \frac{c_g}{\theta}$, implying that the market fully covered (i.e., total demand is inelastic and equal to 1). The demand for the two drug versions are then given by $D_g = F(\widehat{v})$ and $D_b = 1 - F(\widehat{v})$, where

$$\widehat{v} = \begin{cases} \overline{v} & if \quad c_b - c_g \geq (1-\theta)\,\overline{v} \\ \frac{c_b - c_g}{1-\theta} & if \quad c_b - c_g \in ((1-\theta)\,\underline{v}, (1-\theta)\,\overline{v}) \\ \underline{v} & if \quad c_b - c_g \leq (1-\theta)\,\underline{v} \end{cases} . \tag{2}$$

Thus, consumers are willing to buy the generic drug only if it involves a lower copayment. Otherwise, everybody purchases the brand-name drug. The demand sensitivity with respect to copayments crucially depends on the perceived quality difference: a lower θ implies less demand sensitivity.

The producer prices of the brand-name and generic drugs are, respectively, w_b and w_g. Since pharmacies generally have a stronger bargaining position towards producers of generics, it is reasonable to assume that $w_b > w_g$.[11] Assume further that pharmacies can expend effort towards the individual consumer in persuading her to accept generic substitution. More specifically, assume that the perceived quality degradation of the generic drug (θ) depend on the effort e (measured in monetary terms) exerted by the pharmacy: $\theta(e)$, where $\theta'(e) > 0$, $\theta''(e) < 0$ and $\theta(0) = \underline{\theta} \in (0, 1)$.

Denoting the retail prices of the brand-name and the generic drugs by p_b and p_g, respectively, the profit of the pharmacy is given by

$$\pi = m_b D_b + m_g D_g - e, \tag{3}$$

where $m_b := p_b - w_b$ and $m_g := p_g - w_g$ are the margins of the brand-name and generic drug, respectively. We assume throughout the analysis that the producer prices are exogenously given. In the following, we first analyse the pharmacy's incentives for exerting substitution effort for given retail prices (subsection 2.1), before extending the analysis to consider the case where the pharmacy also set retail prices (subsection 2.2). Finally, we derive some testable implications in

[11] In the context of pharmacy incentives for generic substitution, the case of $w_b < w_g$, besides being less realistic, is also less interesting, since this implies that pharmacies would have no incentives for generic substitution as long as the retail price of generics is at or below the retail price of the brand-name drug (which is the realistic price regime).

subsection 2.3.

2.1 Substitution incentives with exogenous retail prices

Suppose that retail prices are exogenously given. The optimal choice of substitution effort in an interior solution is implicitly given by[12]

$$\frac{\partial \pi}{\partial e} = \frac{(m_g - m_b)(c_b - c_g) f(\widehat{v}) \theta'(e)}{(1-\theta)^2} - 1 = 0. \tag{4}$$

As we can see directly from (4), a strictly positive substitution effort requires that (i) the margin is higher for the generic than for the brand-name product, and (ii) the brand-name copayment is larger than the generic copayment. Otherwise, if $m_g < m_b$ or $c_b < c_g$, the pharmacy has no incentive to spend effort on persuading consumers to switch to the generic version. From (4) it follows directly that the optimal substitution effort (in an interior solution) increases with the generic-branded difference in margins $(m_g - m_b)$. Notice also that the amount of substitution effort undertaken depends on the density of demand around the indifferent consumer, which gives a measure of how many consumers that can potentially be persuaded to switch from the brand-name to the generic drug.

More interesting is perhaps the effect of the copayment system on substitution incentives. Assuming an interior solution, $e^* > 0$ such that $\widehat{v}(e^*) \in (\underline{v}, \overline{v})$, the qualitative effect of a marginal increase in the branded-generic copayment difference $(c_b - c_g)$ on optimal substitution effort can be derived from (4), and is given by

$$sign\left\{\frac{\partial e^*}{\partial (c_b - c_g)}\right\} = sign\left\{\frac{\partial^2 \pi}{\partial (c_b - c_g)\partial e} = \frac{(m_g - m_b)\theta'(e)}{(1-\theta)^2}\left[f(\widehat{v}) + \frac{(c_b - c_g)}{1-\theta} f'(\widehat{v})\right]\right\}. \tag{5}$$

A marginal increase in the copayment difference has two different (and potentially counteracting) effects on substitution incentives. These two effects are represented by the two terms in the square brackets of (5). First, a larger copayment difference implies that a given increase in

[12] The second-order condition is

$$\frac{\partial^2 \pi}{\partial e^2} = \frac{(m_g - m_b)(c_b - c_g)}{(1-\theta)^3}\left[f'(\widehat{v})\frac{[\theta'(e)]^2}{1-\theta} + f(\widehat{v})\left[(1-\theta)\theta''(e) + 2[\theta'(e)]^2\right]\right] < 0.$$

θ has a larger effect on $\widehat{v}$. In other words, a larger copayment difference makes it easier to convince consumers with preferences in the neighbourhood of $\widehat{v}$ to switch from the brand-name to the generic drug. All else equal, this increases the pharmacy's incentive to exert substitution effort. However, a larger copayment difference also increases $\widehat{v}$ directly; i.e., it means that the indifferent consumer has a higher willingness to pay for drug treatment. Thus, even if an increase in $(c_b - c_g)$ means that it takes less effort to persuade a given consumer to accept generic substitution, the number of consumers that can potentially be persuaded to make the substitution (i.e., the density of consumers in the neighbourhood of $\widehat{v}$) might be higher or lower. The total effect of copayment differences on substitution incentives therefore depends on the distribution of v. If consumer density is increasing in v, both effects go in the same direction and a larger copayment difference unambiguously leads to higher substitution effort. However, if the density is decreasing in v, and at a sufficiently high rate, a higher copayment difference might lead to lower substitution effort instead. This will be the case if the reduction in the number of consumers that can potentially be persuaded to accept generic substitution is sufficiently large to outweigh the effect that these consumers become easier to persuade. Notice also that $\frac{\partial e^*}{\partial(c_b - c_g)} > 0$ if and only if $\frac{\partial[(c_b - c_g) f(\widehat{v})]}{\partial(c_b - c_g)} > 0$. If this condition holds, it follows directly from (4) that a larger copayment difference will also reinforce the positive relationship between relative margins $(m_b - m_g)$ and substitution effort.

Proposition 1 *(i) The optimal substitution effort in an interior solution is increasing in the difference in margins between generics and brand-names* $(m_g - m_b)$*. (ii) If* $f(\widehat{v}) + \frac{(c_b - c_g)}{1-\theta} f'(\widehat{v}) > 0$*, a marginal increase in the copayment difference* $(c_b - c_g)$ *leads to higher substitution effort and reinforces the effect stated in (i).*

Suppose that $f(v)$ is either increasing or sufficiently weakly decreasing, such that $f(\widehat{v}) + \frac{(c_b - c_g)}{1-\theta} f'(\widehat{v}) > 0$. In this case, the second part of Proposition 1 has clear-cut implications for the effects of different types of copayment systems on generic substitution. Consider a simple coinsurance regime, where the copayment is defined as

$$c_i = \alpha p_i + k, \quad i = b, g, \tag{6}$$

where $\alpha \in (0,1)$ is the coinsurance rate and k is a deductible. With this copayment scheme, the branded-generic copayment difference is given by $c_b - c_g = \alpha (p_b - p_g)$. Thus, the higher the coinsurance rate (α), the higher is the optimal substitution effort and the stronger is the effect of relative margins on substitution incentives.

Another widely used copayment regime is reference pricing, where consumers have to pay the full price difference between generic and brand-name drugs if choosing to purchase the latter. In this case, the copayment schedule is given by

$$c_i = \begin{cases} \alpha r + (p_b - r) + k & if \quad i = b \\ \alpha p_g + k & if \quad i = g \end{cases}, \tag{7}$$

where $r \in (p_g, p_g)$ is the reference price. The branded-generic copayment difference is now given by $c_b - c_g = p_b - \alpha p_g - (1-\alpha) r$. We see that, compared with a simple coinsurance scheme $(r = p_b)$, reference pricing $(r < p_b)$ increases the branded-generic copayment difference. Thus, for given retail prices, and as long as $f(v)$ is either increasing or sufficiently weakly decreasing, reference pricing increases the optimal substitution effort and strengthens the relationship between relative margins and substitution incentives.

The above analysis applies for the case of exogenously given retail prices. In the next subsection we analyse incentives for generic substitution when the pharmacy can also set the retail prices of the generic and brand-name drugs. In order to facilitate the analysis, we assume that consumers' willingness to pay for drug treatment is uniformly distributed on $[\underline{v}, \overline{v}]$, implying $f(v) = \frac{1}{\overline{v} - \underline{v}}$ and $f'(v) = 0$. From Proposition 1 we know that this assumption establishes an unambiguously positive relationship between the copayment difference and the optimal substitution effort.

2.2 Substitution incentives with endogenous retail prices

If the pharmacy can set retail prices, it has another instrument to steer demand towards the most profitable drug version. Given that copayments depend on prices, demand for the two drugs depend on the retail price difference between the brand-name and the generic drugs. For a given value of θ, the pharmacy faces the following trade-off when deciding the optimal retail price difference. If $p_b = p_g$, the generic drug is more profitable for the pharmacy to sell (since $w_g < w_b$), but in order to make consumers choose the generic drug, it has to be priced lower than the brand-name. The further p_g is reduced below p_b, the larger is the share of consumers choosing the generic. However, lowering p_g reduces the profitability of selling the generic drug. Thus, the pharmacy maximises profits by choosing a branded-generic retail price difference that optimally trades off these two incentives.

As long as total demand is inelastic, the pharmacy would obviously want to set the optimal price difference at the highest possible *level*. Thus, we assume that retail price setting is restricted by price cap regulation, that specifies the highest possible retail price that the pharmacy can set. From the above discussion, if follows that the price cap always binds for the brand-name drug. In the following, we will briefly discuss optimal retail price setting and implications for substitution incentives under different copayment scenarios.

2.2.1 Simple coinsurance

Assume that copayments are given by (6). Maximising (3) with respect to p_g, the optimal retail price difference is given by

$$p_b - p_g = \frac{(w_b - w_g)}{2} + \frac{(1-\theta)\,\underline{v}}{2\alpha}. \tag{8}$$

Notice that the retail price difference is constant, implying that any change in the brand-name retail price (e.g., due to stricter price cap regulation) will be exactly matched by a corresponding change in the generic retail price.[13] Demand for the generic drug is given by

$$D_g = \frac{\alpha\,(w_b - w_g) - (1-\theta)\,\underline{v}}{2\,(\overline{v} - \underline{v})\,(1-\theta)}. \tag{9}$$

[13] This property follows from the assumptions of full market coverage and uniform distribution of v.

Inserting the optimal price difference into (4), with $f(v) = \frac{1}{\overline{v}-\underline{v}}$, the first-order condition for optimal substitution effort is given by

$$\frac{\alpha (w_b - w_g)^2 \theta'(e)}{4(\overline{v}-\underline{v})(1-\theta)^2} - 1 = 0. \tag{10}$$

When the generic price is optimally adjusted, substitution effort depends only on the branded-generic producer price difference. A higher producer price for the brand-name (generic) drug will increase (reduce) substitution effort. If we consider the relationship between producer prices and market shares, pharmacy incentives for expending substitution effort will have reinforcing effects when the branded-generic retail price difference is endogenous. A reduction in the brand-name (generic) producer price leads to an increase (reduction) in the generic retail price, which directly increases demand for the brand-name (generic) drug. This effect is reinforced by the fact that the pharmacy will spend less (more) effort on generic substitution.

2.2.2 Reference pricing

Consider a reference pricing scheme where copayments are given by (7). Assuming that $r \in (p_g, p_b)$, the optimal generic retail price (hence implicitly the optimal retail price difference), is given by

$$p_g = \frac{(1+\alpha)p_b - (1-\alpha)r - \alpha(w_b - w_g) - (1-\theta)\underline{v}}{2\alpha}. \tag{11}$$

This price is indeed below the reference price if $p_b < r + \frac{\alpha(w_b-w_g)+(1-\theta)\underline{v}}{1+\alpha}$. Demand for the generic drug is now

$$D_g = \frac{(1-\alpha)(p_b - r) + \alpha(w_b - w_g) - (1-\theta)\underline{v}}{2(\overline{v}-\underline{v})(1-\theta)}. \tag{12}$$

If $r = p_b$, this solution is obviously identical to the solution under a simple coinsurance system. Thus, we can analyse the effect of reference pricing by considering a marginal reduction in r, evaluated at $r = p_b$. The effect on the optimal retail price is given by $\frac{\partial p_g}{\partial r} = -\frac{1-\alpha}{2\alpha} < 0$, implying that reference pricing reduces the optimal price difference between brand-names and generics. The reason is that reference pricing increases consumer incentives for generic substitution, as the demand becomes more price sensitive above the reference price. However, this means that the pharmacy's optimal substitution effort increases, since the difference in margins becomes larger (due to the higher generic retail price). This is easily seen by substituting p_g from (11) into the first-order condition for optimal substitution effort, yielding:[14]

$$\frac{\left(\left(1-\alpha\right)\left(p_b-r\right)+\alpha\left(w_b-w_g\right)\right)^2-\left(\left(1-\theta\right)\underline{v}\right)^2}{4\left(\overline{v}-\underline{v}\right)\left(1-\theta\right)^2\alpha}\theta'\left(e\right)-1=0. \tag{13}$$

Proposition 2 *If pharmacies are free to set retail prices (but subject to price cap regulation) and if consumers' willingness to pay for drug treatment is uniformly distributed, the introduction of reference pricing will reduce the retail price difference between brand-names and generics and increase the pharmacy's optimal choice of substitution effort.*

The first result, that reference pricing reduces the branded-generic price difference is in line with a previous result shown, and also empirically confirmed, by Brekke et al. (2011). The second result, that reference pricing leads to higher substitution effort, is consistent with the result reported in the second part of Proposition 1 and shows that, at least for a uniform distribution of v, the positive effect of reference pricing on substitution effort holds regardless of whether retail prices are exogenous or not. This suggests that the positive effect of reference pricing on generic market shares previously reported in the literature (see, e.g., Brekke et al., 2011) could be partly explained by increased substitution effort of pharmacies.

2.3 Testable implications

We are interested in the pharmacies' role in promoting generic competition. In particular, we analyse the relationship between pharmacies' financial incentives (product margins) and the market shares of brand-names and generics. Pharmacies would of course prefer to sell generics if the generic (brand-name) margin is higher than the brand-name margin, and vice versa. Our theoretical model argues that generic substitution is costly for the pharmacies, since they

[14] It is straighforward to show that our results are qualitatively similar if we endogenise the reference price and let it be a function of actual drug prices in the market, for example by the formula

$$r=\beta p_g+\left(1-\beta\right)p_b,$$

where $\beta\in(0,1)$. See Brekke et al. (2011) for a more thorough analysis of the difference between exogenous and endogenous reference pricing.

need to persuade patients. Product margins are therefore crucial for pharmacies' incentives to expend promotional effort on generic substitution. Our data allow us to observe product margins and generic sales at pharmacy level. However, the pharmacies' effort related to generic substitution is generally hard to observe. Creating a good measure of such effort would require detailed information on the time spent by pharmacists at the dispensing point. A more crude measure would be to observe the frequency of generic substitution, which would require detailed information about the prescriptions made by the physician, especially whether a brand-name was prescribed, and the purchase made by the patient. Unfortunately, we do not have this kind of detailed information. Our empirical strategy will therefore be to use the relationship between product margins and market shares (brand-name versus generic). This strategy is based on the following theoretical implications of the above analysis.

Assuming that the brand-name drug is subject to (binding) price cap regulation, implying that p_b is exogenous (along with w_b and w_g), the optimal generic retail price and the optimal promotion effort, denoted by $p_g^*(p_b, w_b, w_g)$ and $e^*(p_b, w_b, w_g)$ are given by the simultaneous solution to (4) and (8) under simple coinsurance, and (4) and (11) under reference pricing. The demand for generics can therefore be expressed, on general form, as

$$D_g\left(p_b, p_g^*(p_b, w_b, w_g), \theta\left(e^*(p_b, w_b, w_g)\right)\right).$$

Since total demand is assumed to be perfectly inelastic, there is a one-to-one relationship between demand for the generic drug and its market share. Thus, the effect of a marginal increase in the brand-name producer price on the generic market share is given by

$$\frac{\partial D_g}{\partial w_b} = \frac{\partial D_g}{\partial p_g}\frac{\partial p_g^*}{\partial w_b} + \frac{\partial D_g}{\partial \theta}\theta'(e)\frac{\partial e^*}{\partial w_b} > 0. \tag{14}$$

Both terms on the right-hand side of (14) are positive. The first term is the demand effect caused by a change in the copayment difference between brand-name and generic drugs, for a given level of substitution effort. An increase in the brand-name producer price will lead to a drop in the generic retail price, regardless of whether the copayment scheme is based on simple coinsurance or reference pricing (cf. (8) and (11)). The drop in p_g makes the brand-name drug relatively more expensive and increases the generic market share. The second term is the demand effect caused by a change in substitution effort. For given retail prices, an increase in the brand-name producer price increases the difference in product margins between generics and brand-names, which increases the pharmacy's optimal choice of effort (cf. Proposition 1).

Thus, an increase in the brand-name producer price increases the generic market share through two different channels: a lower generic retail price and a higher substitution effort.[15] However, since effort is unobservable, it is not possible to estimate the second effect directly. What we can do instead is to estimate the effect of changes in producer prices on market shares, controlling for retail prices. This allows us in principle to isolate the second effect, since, for given retail prices, a change in producer prices is equivalent to a change in product margins only, which affects the pharmacy's incentives for promoting generics but does not affect relative copayments. If pharmacies are not willing or able to spend effort on persuading consumers to switch from brand-names to generics, we would not expect to find any effect of changes in product margins on market shares, when controlling for retail prices.

Given that the density of patients is either increasing or sufficiently weakly decreasing in the willingness-to-pay for drugs, our theoretical analysis also shows that the effect of a change in product margin differences between brand-names and generics on optimal promotion effort is larger under reference pricing than under a simple coinsurance system (cf. Proposition 1 in conjunction with (7)). In other words, the second term in (14) is larger if the copayment system for drugs is based on reference pricing.

Relying on the assumption that $f(v)$ is either increasing or sufficiently weakly decreasing, our theoretical analysis therefore allows us to formulate two predictions that can be tested with our data:

(i) A larger difference in margins between generics and brand-names increases the market share of generics;

[15] It is straightforward to show that an increase in the generic producer price has the exact opposite effect: it increases the generic retail price and reduces the substitution effort, leading to a lower generic market share.

(ii) The effect postulated in (i) is stronger in therapeutical markets where drugs are subject to reference pricing.

3 Institutional Background

The Norwegian pharmacy market was liberalised in 2001. Before the liberalisation, entry and location were determined by a governmental health agency, and ownership was restricted to pharmacists. The new act removed these restrictions, making Norway one of the pioneers in Europe in this regard. Most European countries still have strict restrictions on entry and ownership, though the European Commission is pushing for deregulation of the pharmacy sector.

The liberalisation in Norway caused dramatic changes to the pharmacy market structure. Almost over night most of the about 400 pharmacies owned by self-employed pharmacists were sold to three international wholesalers. The three wholesalers are Norsk Medisinaldepot (owned by Celesio AG), Alliance Healthcare (owned by Alliance Boots Ltd) and Apokjeden (owned by Tamro Oy and Phoenix AG). Besides purchasing existing pharmacies, the wholesalers have established many new pharmacies, especially in non-rural areas. The number of pharmacies increased to 662 in 2009, which is an increase of almost 70 percent since 2001.

[Table 1 about here]

As can be seen from Table 1, the four pharmacy chains Alliance, Apotek 1, Vitusapotek and Ditt Apotek cover more than 96 percent of the total number of pharmacies. Three of these chains (Alliance, Apotek 1, and Vitusapotek) consist of pharmacies that are owned by the wholesalers. The fourth chain (Ditt Apotek) is a franchise of Norsk Medisinaldepot. The remaining pharmacies are independent of the wholesalers, but purchase their products from the wholesalers. The three wholesalers cover the whole pharmacy retail market for pharmaceuticals.

The pharmaceutical market is extensively regulated, which has implications for market structure and firm behaviour. First, pharmaceutical producers cannot have ownership in pharmacies, and vice versa. This is a common restriction in Western countries. Second, wholesalers are required to store and deliver the full range of pharmaceuticals that are demanded by patients (prescribed by doctors).[16] This implies that wholesalers must carry both brand-names and generics and cannot exclusively offer either. Third, the demand for prescription drugs is subsidised at the point of consumption due to medical insurance. Patients pay only a fraction (36 percent) of the drug price. However, the patients' copayments are restricted by expenditure caps. Once these caps are reached, the government covers 100 percent of the additional medical expenditures. According to LMI (2009) the *de facto* patient copayment is about 30 percent of the total pharmaceutical spending. Fourth, prescription drug prices are subject to price cap regulation. The maximum price for a given drug is based on international price comparisons (external referencing) and imposed at wholesale level.[17] The price cap at pharmacy retail level is derived by adding a regulated mark-up that pharmacies are allowed to charge. Notably, brand-names and generics face the same price cap, but in practice the price cap is usually only binding for the higher priced brand-names. The prices at producer (ex-manufacturer) level are not subject to regulation.

In 2003 the government introduced reference pricing (internal referencing) for a subsample of the off-patent molecules with generic competition. This system has been extended to all new molecules for which the patent expires and generic competition takes place.[18] The reference price, which is the maximum reimbursement for all products with a given molecule, is defined as a "discount" on the price cap for this molecule.[19] The firms are free to charge prices above the reference price (though constrained by the price cap). However, if a product is priced above the reference price, patients that demand this drug must pay the difference between the charged price and the reference price out-of-pocket (in addition to coinsurance). This price difference

[16] "Important" drugs should be delivered within 24 hours, while less important drugs have a 48 hour delivery deadline.

[17] Producers must report their prices in nine reference countries (Austria, Belgium, Denmark, Finland, Germany, Irland, the Netherlands, Sweden and United Kingdom). The price cap is defined as the average of the three lowest prices in the reference countries and updated annually.

[18] There has also been a modification of the reference price system. The first version called "indekspris" defined the reference price as a sales weighted sum of brand-name and generic prices (see Brekke et al., 2009, 2011). This system was replaced by "trinnpris" in January 2005, where the reference price is calculated as a discount on the price cap prior to generic competition.

[19] The discount is progressive. First, the reference price is 70 percent of the price cap before generic competition. Then after 6 months the reference price is reduced to 45 or 25 percent depending on it sales value. Finally, after 18 months the reference price is reduced to 35 or 20 percent.

will not be covered by the public insurer even if the patient's medical costs have reached the expenditure cap. The intention is to induce consumers to substitute to a lower priced generic and/or get the brand-name producer to reduce its price.

4 Data and descriptive statistics

For the empirical analysis, we have obtained register data from the Norwegian Institute of Public Health. Our data are extracted from two different databases; the Prescription and the Wholesale database. The Prescription database contains information about all prescription bound sales at pharmacy level in Norway from 2004 and onwards. From this database we have obtained data on average prices and volumes per month over a four-year period (2004-7). Prices and volumes are in defined daily doses (DDD) per product per pharmacy. The data also contain detailed information about product name, manufacturer, launch date, pack size, strength, presentation form (e.g., tablet, capsule, injection), etc. The Wholesale database contains information about producer (ex-manufacturer) prices (in DDD) per product per wholesaler per month. In order to merge these two data sets we have obtained detailed information about ownership and chain affiliation of each pharmacy for the sample period.

In order to study pharmacies' generic substitution incentives, we have generated a data set with 70 off-patent substances, where brand-names face *de facto* competition from generic versions.[20] However, since pharmacies are only allowed to substitute products with the same substance, strength and presentation form, we aggregate our data at substitution group level. The substitution groups are defined by the regulator (Norwegian Medicines Agency) and specify the set of products that pharmacies are allowed to dispense to patients with a prescription of a given (brand-name) drug.[21] Basing the analysis on substitution group level rather than substance level, allows us to more precisely estimate the impact of pharmacies' product margins on the sales of brand-names and generics.

The empirical analysis includes all vertically integrated pharmacies. As shown in the previous

[20] Table A1 in the Appendix provides a complete list of the set of substances in our sample, as well as descriptive statistics of our key variables.

[21] In Table A1 in the Appendix, we report the number of substitution groups for each substance.

section, 85 percent of the pharmacies on the Norwegian market are owned by the wholesalers, which means that our data covers most of the prescription bound sales. The relevant margin for this set of pharmacies is the joint wholesaler-pharmacy margin. Focusing only on the pharmacy margin itself is of less interest, since the pharmacy purchasing price is simply an internal price in the vertically integrated firm.[22]

The joint wholesaler-pharmacy margin is defined as the difference between the pharmacy retail price and the producer (ex-manufacturer) price. For each of the three wholesalers, we calculate separate brand-name and generic prices and market shares as averages for each substitution group. At retail level this implies that we aggregate prices and market shares across pharmacies owned by the same wholesaler.[23]

Table 2 below provides an overview of the means and standard deviations of our key variables across the three pharmacy chains, as well as the industry figures.[24]

[Table 2 about here]

The table shows an average brand-name market share for the industry of 41.9 percent, but with differences across wholesalers, varying from 34.1 to 45.6 percent. Notice also that Table A.1 in the Appendix reports considerable variation in brand-name market shares across substances. As expected the brand-names are consistently priced higher than the generics at both producer and retail level. This pattern is consistent across the wholesalers. In line with our theory, we see that the generic margin is substantially higher than the brand-name margin. At industry level the average generic margin is NOK 8.22 at industry level, while the average brand-name margin is NOK 5.35. The margin differences, defined as the generic margin net of the brand-name margin, vary from NOK 2.46 to NOK 3.57 across the wholesalers.[25]

[22] Alternatively, we could have considered the independent pharmacies, but this would have required information about pharmacy purchasing prices, which is not available.

[23] To check that our results are not sensitive to aggregation bias, we have also aggregated data at pharmacy level. The results are qualitatively similar to the ones reported in Table 3 in Section 5, and are available upon request.

[24] Table A.1 in the Appendix report the same figures for each substance in our sample.

[25] While the generic margins are higher than the brand-name margins on average, this is not the case for every substance. As can be seen from Table A1 in the Appendix, for 9 out of 70 substances the margin difference is negative.

Since we are interested in the relationship between the (difference in) product margins and market shares, it is useful to see how these variables develop over time. In Figure 1-3 we plot the changes in our key variables for each of the three wholesalers for the four-year period from 2004 to 2007. The figures are based on products in substitution groups that are present in our sample for the whole period. The reason is that entry and exit of products (substitution groups) shift margins and market shares, so that trends would be hard to detect from the figures.[26]

[Figures 1-3 about here]

The figures show a clear tendency. The average margin difference increases over time, whereas the average brand-name market share decreases over time. The trends are fairly similar for wholesalers 1 and 3. The brand-name market share drops from about 45-50 percent down to around 30 percent, while the margin difference increases from around 0.4 NOK up to 1 NOK. For wholesaler 2 the picture is somewhat different. The initial brand-name market share is higher (around 65 percent), and the increase in the margin difference is stronger (about 1 NOK) in the first part of the period. In the second part of the period, the brand-name margin and the margin difference tend to stabilise at the same level as wholesaler 1 and 3. The descriptive statistics in Table 2 and the graphs in Figure 1-3 indicate a relationship between the margin difference between generics and brand-names and their market shares. We take a closer look at this in the next section.

5 Empirical method and results

In this section we aim at testing the two main predictions from the theoretical analysis: (i) a larger difference in the margins between generics and brand-names decreases (increases) the market share of brand-names (generics); and (ii) the effect postulated in (i) is stronger in therapeutical markets where drugs are subject to reference pricing. To test the first prediction, we estimate the following fixed effect model:

[26] About 50 percent of the products (substitution groups) are present in our data for the whole period. Thus, the figures should be fairly representative for our sample.

$$Y_{ikt} = \alpha + \beta \Delta m_{ikt} + \gamma \Delta p_{ikt} + \lambda RP_{it} + s_i + \omega_k + \delta_t + \varepsilon_{ikt}, \tag{15}$$

where Y_{ikt} is the market share of brand-names within substitution group i at pharmacies belonging to wholesaler k at time t. In the regression we include fixed effects for substances (s_i) and wholesalers (ω_k). The substance fixed effects capture time-invariant, unobserved (and observed) factors that affect the market shares of brand-names. This could be substance characteristics such as the share of brand-loyal consumers (or physicians), type of patients (age, gender), type of disease (chronic or acute), type of product (tablet, capsule, injection), etc. The wholesaler fixed effects capture time-invariant factors that influence the brand-name market shares. This may include wholesaler characteristics such as pharmacy chain profiles, marketing strategies, distribution costs, pharmacy locational patterns (urban vs. rural), etc. We also include a time dummy δ_t that captures time trends in brand-name market shares that are common across substances and wholesalers, and dummy for whether or not the products are subject to reference pricing (RP).

We are interested in estimating the impact of the margin difference between brand-names and generics (Δm_{ikt}) on their market shares. In doing so, it is important to control for the difference between brand-name and generic prices at pharmacy (retail) level (Δp_{ikt}). The reason for this is that a change in the pharmacy prices affects both the margin and the copayment, as explained in the theory section. Thus, controlling for the demand effect of copayment changes is therefore important in order to consistently estimate the impact of margins on market shares.[27]

Including pharmacy (retail) price differences in the regression implies that the effect of margins on market shares are identified by the brand-name and generic prices at *producer* level. To see this, we can write margin difference as follows:

$$\Delta m := (p_b - w_b) - (p_g - w_g) = (p_b - p_g) + (w_g - w_b).$$

[27] We use the pharmacy price difference as a proxy for the copayment difference. As shown in Section 2, a one unit change in the price difference leads to an α unit change in the copayment difference, with $\alpha \in (0, 1)$ being the coinsurance rate. The relationship is stronger under reference pricing, but still less than one. Using the pharmacy price difference may therefore imply that we underestimate the effect of copayments on market shares. Moreover, since pharmacy price changes also influence the margins, we cannot rule out that this variable also includes a margin effect.

Thus, controlling for the pharmacy price difference implies that the margin difference is equivalent to the difference in producer prices. Using the margin difference directly would not generate any problems for the interpretation of the effect of margins on market shares. However, the interpretation of the effect of the pharmacy price difference would be unclear. We therefore define Δm_{ikt} as the difference between the generic and the brand-name producer prices ($w_g - w_b$).

The results from the fixed effect regressions are reported in Table 3. In these models we implicitly assume that the differences in producer prices (margins) and pharmacy retail prices are exogenous. In Section 5.2 we address potential endogeneity problems.

[Table 3 about here]

Our results (Model 1) indicate significant effects of differences in the pharmacies' margins on generic and brand-name products on the brand-name market shares. As mentioned above, we measure the difference in pharmacy margins by the difference between generics and brand-name producer prices, which means that a larger producer price difference is equivalent to a lower margin on generics relative to the brand-name.[28] Our results show that a 1 NOK increase in the producer price difference (i.e., a 1 NOK reduction in the margin difference between generics and brand-names) leads to a 0.49 percentage points increase in the brand-name market shares. The pharmacy price difference has the expected effect on market shares. A 1 NOK increase in the pharmacy price (copayment) difference between brand-name and generics is associated with a 0.77 percentage point reduction in the brand-name market share. These empirical results are consistent with our first prediction from the theoretical analysis.[29]

[28] Estimating the model using the margin difference gives obviously the same results, but the coefficient associated with the pharmacy price difference variable becomes harder to interpret, as explained above.

[29] We have performed a number of robustness analyses: (i) control for the number of generics per substance per period; (ii) estimate more flexible specifications where we allow for non-linear effects of pharmacy price differences, and also allow price differences to have different effects in different periods; and (iii) include substance-specific time trends. In each of these alternative specifications, the main results (which are available upon request) remain qualitatively similar to the ones reported in Table 3.

5.1 The role of the copayment structure

Our theoretical analysis pointed out that the copayment structure affects the pharmacies' substitution incentives. The pharmaceuticals in our data are either under standard coinsurance or reference pricing. Table A.1 in the Appendix shows which substances were subject to reference pricing and when they were included in the scheme. Based on the theoretical analysis, we expect pharmacies to expend more effort on persuading consumers to switch to generics under reference pricing, since, for a given retail price difference, the copayment difference is larger under reference pricing than under simple coinsurance. Thus, there should be a stronger relationship between brand-name and generic product margins and their market shares for the drugs that are exposed to reference pricing. To test this we interact the margin difference with a reference pricing dummy:

$$Y_{ikt} = \alpha + \beta_1 \Delta m_{ikt} + \beta_2 \Delta m_{ikt} * RP_{it} + \gamma \Delta p_{ikt} + \lambda RP_{it} + s_i + \omega_k + \delta_t + \varepsilon_{ikt} \qquad (16)$$

The results are reported Table 3 (Model 2). We see that the effect of the producer price (margin) difference on the brand-name market share is substantially higher for products under reference pricing. A 1 NOK increase in the producer price difference (i.e., a 1 NOK decrease in the margin difference between generics and brand-names) is associated with a 1.37 percentage point increase in the brand-name market share. For products under regular coinsurance, a similar change in the margin difference is associated with only a 0.58 percentage point increase in the brand-market share. This finding is consistent with the second prediction from our theoretical analysis.

5.2 Asymmetric effects

In our theoretical model, we have implicitly assumed that pharmacies can spend effort to persuade, but never to dissuade, consumers to buy a generic drug instead of the brand-name. This implies that changes in product margins should only affect market shares within substitution groups where generic margins are higher than the brand-name margin. However, for substitution groups where the margin is higher for the brand-name drug, the pharmacy may have an incentive to dissuade consumers who ask for generic substitution themselves, or to recommend the brand-name drug to patients who enter the pharmacy with a prescription for a generic drug. We test for the potential existence of asymmetric effects along these lines by including a dummy variable that takes the value 1 for products which belong to substitution groups where the brand-name margin is higher than the generic margin and 0 otherwise, and interacting this variable with the producer price difference Δm_{ikt}. The results are shown in Table 4.

[Table 4 about here]

We see that the effect of an increase in the producer price difference (between generics and brand-names) on the brand-name market share is positive for both types of substitution groups, but the effect is significantly stronger for substitution groups where the generic margin is higher (0.470 compared with $0.470 - 0.159 = 0.311$). These results suggest that the promotional effort of pharmacies is mainly directed towards persuading consumers to accept generic substitution. A plausible explanation for these asymmetric effects is that explicitly dissuading consumers from generic substitution can be perceived as a violation of government regulations and such activities will therefore be associated with a higher disutility of effort for the pharmacy.

5.3 Potential endogeneity

Controlling for pharmacy retail price differences when estimating the effect of changes in producer prices on market shares gives rise to an endogeneity problem. If pharmacies respond to changes in producer prices by changing the pharmacy retail prices, this may lead to inconsistent estimates of the effect of margins on market shares. The reason is that in this case we cannot assume the pharmacy price difference to be fixed.

As previously described, the brand-name pharmacy prices are usually capped by regulation, and thus exogenous. However, as explained in the theory section, pharmacies have an incentive to respond to changes in producer prices by optimally adjusting the generic retail prices. Therefore, the pharmacy retail price difference is likely to be endogenous.

A common way to deal with endogenous explanatory variables is to use IV regression. To consistently estimate the effect of changes in margin differences on market shares we need an instrument variable that is correlated with pharmacy retail price differences, but not with the market shares. We use Danish pharmacy retail price differences as instruments. The price data are collected from a publicly available database provided by the Danish regulatory agency (Lægemiddelstyrelsen).[30] We compute the monthly average brand-name and generics prices for each substance, and use this to calculate the pharmacy retail price differences in Denmark. This instrument should be valid. There is no reason to believe that the Danish pharmacy price differences should influence the brand-name market shares or the producer price differences in Norway.

We apply a fixed effect IV estimator[31] that is robust to, and efficient in the presence of, arbitrary serial correlation and heteroskedasticity (see Baum, Schaffer and Stillman, 2007).[32] Orthogonality of the instruments is tested by Hansen's J statistic, which is consistent in the presence of heteroskedasticity and autocorrelation (the null hypothesis is that the instruments are uncorrelated with the error term). However, instrument exogeneity is only one of the two criteria necessary for instruments to be valid. If the instruments are uncorrelated, or only weakly correlated, with the endogenous variables, then sampling distributions of the IV statistics are in general non-normal. In this case, standard IV estimates, hypothesis tests and confidence intervals are unreliable. Hence, tests for underidentification and weak identification are reported.[33]

The results from the fixed effect IV model are reported Table 5 below.[34]

[Table 5 about here]

As seen from the table, we have price data from Denmark for 58 out of 70 substances. The

[30] These prices can be found at www.medicinpriser.dk.

[31] IV models were estimated using the Stata module xtivreg2 (Schaffer, 2007).

[32] The long-run heteroskedasticity and autocorrelation consistent covariance matrix is generated using the Bartlett kernel function with a bandwidth of 12. According to Baum, Schaffer and Stillman (2007), a common choice of bandwidth for these kernels is a value related to the periodicity of the data, i.e., 12 for monthly.

[33] The underidentification test is a Lagrange multiplier (LM) test of whether the excluded instruments are correlated with the endogenous regressors (the null hypothesis is that the equation is underidentified). The weak instrument test statistic is based on the Kleibergen-Paap rk statistic. As a "rule of thumb" this F-statistic should be at least 10 for weak identification not to be considered a problem (Staiger and Stock, 1997).

[34] First step results are available upon request.

reason that some substances drop out is that either the brand-name or the generic has a 100 percent market share in Denmark. In order to check whether the results are sensitive to this exclusion, we estimate the same model (Model 1) as presented in Table 3. We see that the results are almost identical.

As can be seen from Table 5, we estimate two different IV fixed effect regressions. In Model 2 we use the Danish price differences in period t as instruments, while in Model 3 we also include the price differences in period $t-1$. The tests indicate that both models are identified, and that there are no problems with weak instruments. The Sargan-Hansen test in Model 3 fail to reject the null hypothesis (i.e., the instruments are uncorrelated with the error term), suggesting that the instruments are valid.

The results from the IV regressions are fairly similar to the ones reported in Model 1. We see that the effect of the producer price differences on brand-name market shares becomes somewhat weaker, whereas the effect of the pharmacy retail price difference becomes stronger. This suggests limited problems with endogenous explanatory variables, and the results are consistent with the first prediction from our theoretical analysis.

6 Policy implications

As mentioned in Section 2, the previous literature on generic competition has focused either on physicians' prescribing practices or on the design of the patient reimbursement system for prescription drugs. In the present paper, we have found that pharmacy incentives are also likely to play a crucial role in determining generic sales and thereby total pharmaceutical expenditures. What are the possible policy implications of this finding? We would here like to emphasise two different implications for optimal regulation of pharmaceutical markets that follow from our analysis.

First, our empirical results indicate that pharmacy margins on branded versus generic drugs have a sizeable impact on generic market shares. This suggests that mark-up regulation at the pharmacy level could potentially be an additional powerful instrument in order to stimulate generic competition and thereby obtain cost savings. However, the important lesson from our analysis is that the effect of mark-up regulation on generic competition depends crucially on the design of the regulation scheme. More specifically, a regressive mark-up scheme that provides lower absolute margins on higher priced drugs (brand-names) will provide pharmacies with incentives to steer demand towards cheaper generic drugs. On the other hand, a fixed percentage mark-up will automatically imply that pharmacies have higher margins on (higher-priced) brand-name drugs, which is detrimental for stimulating generic competition. Although these insights are not new, our empirical analysis suggests that the quantitative impact of qualitatively different mark-up schemes is potentially large.

Second, our analysis also casts additional light on the effects of a widely used instrument for stimulating generic competition, namely reference pricing. In our theoretical model, we show that reference pricing reinforces pharmacy incentives for expending effort on persuading consumers to switch from brand-names to generics. We are also able to confirm this effect in our empirical analysis. Thus, by explicitly taking pharmacy incentives into account, we are able to identify an additional channel through which reference pricing stimulates generic competition. Our analysis can therefore be seen as offering an additional argument for introducing reference pricing (or any other reimbursement scheme that increases the relative patient copayment for branded versus generic drugs) in order to contain the growth in pharmaceutical spending.

7 Concluding remarks

The functioning of pharmaceutical markets is complex and far from perfectly understood. One of the most studied yet less understood issues, is that of generic competition in the off-patent market for prescription drugs. Compared to markets for ordinary consumption goods, a complicating factor is that demand for prescription drugs is partly determined as a result of interactions between prescribing physicians and patients. However, we argue that there are also other complicating, and less understood, factors. In the present paper, we have examined a hitherto neglected factor in explaining generic competition, namely the role of dispensing pharmacies. More specifically, we have analysed – theoretically and empirically – the incentive for pharmacies to promote generic instead of brand-name drugs.

Based on a theoretical model of vertical differentiation, we show that pharmacy incentives to steer demand towards generic drugs are increasing in the product margin difference between generics and brand-names, and these incentives are also stronger the larger the copayment difference between brand-names and generics. These effects are empirically confirmed in the second part of our paper, where we use Norwegian data on sales and prices at both producer (ex-manufacturer) and retail (pharmacy) level for 70 off-patent substances with generic competition over a four-year period (2004-7). Controlling for retail price differences of brand-names and generics, we find strong and highly significant effects of the difference in brand-name and generic margins on their market shares, implying that pharmacies are expending more effort on promoting generics when their margins on generics are high relative to those on brand-names. Thus, our results strongly suggest that dispensing pharmacies are not perfect agents for patients and that pharmacy incentives are important for stimulating generic sales.

Before concluding the paper, we would like to stress some potential caveats with our study. Our theoretical analysis takes producer prices as given. Obviously, this is a simplifying assumption. Producer prices are determined in negotiations between the (brand-name and generic) producers and the wholesalers. It would be of great interest to study the determination of the producer prices as a result of a bargaining game between these two parties, but this is clearly beyond the scope of the paper and is therefore left for future research.

In our empirical study, we observe gross product margins. However, distribution costs might differ across wholesalers and pharmacy chains, and give rise to different net margins. Moreover, we do not observe potential side-payments between the producers and the wholesalers, which might affect the overall profitability of selling specific products. However, as long as these factors are fairly consistent over time, they should be captured by our substance-wholesaler fixed effects. There are also regulations that restricts the use of side-payments. The government requires that discounts given to the wholesalers should be reflected in the producer prices and cannot be given as a fixed lump-sum transfer. It is also the case that the distributors' incentives are affected by the marginal profitability of selling a specific product, which is exactly what we find in our data.

Appendix: Detailed descriptive statistics

A complete list of the set of substances in our sample, with descriptive statistics on key variables, are given in Table A1.

[Table A.1 about here]

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Tables

Table 1. Pharmacy chains, number of pharmacies, 2009.

Alliance apotekene	144
Apotek 1	244
Vitusapotek	169
Ditt Apotek (hospital pharmacies)	81 (33)
Independent pharmacies	24
Total	662

Table 2. Sample characteristics, means and standard errors in parentheses.

	Wholesaler 1	Wholesaler 2	Wholesaler 3	Industry		
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Min	Max
Brand-name market share	34.11 (27.03)	45.14 (29.64)	45.55 (31.85)	41.86 (30.11)	0.02	99.98
Brand-name producer price[1]	7.56 (19.90)	8.36 (18.80)	8.36 (19.22)	8.11 (19.29)	0.12	170.85
Generic producer price[1]	2.67 (4.77)	2.76 (4.00)	2.96 (4.62)	2.80 (4.47)	0.06	63.65
Brand-name retail price[1]	12.40 (29.01)	13.82 (27.91)	14.06 (28.57)	13.46 (28.49)	0.47	246.11
Generic retail price[1]	9.97 (23.20)	11.79 (24.41)	11.19 (21.21)	11.01 (22.97)	0.42	235.79
Brand name margin	4.84 (9.54)	5.46 (9.49)	5.70 (9.78)	5.35 (9.61)	0.01	86.67
Generic margin	7.30 (19.84)	9.03 (22.03)	8.23 (18.40)	8.22 (20.15)	0.02	203.73
Margin difference	2.46 (11.64)	3.57 (13.89)	2.53 (9.89)	2.86 (11.92)	-28.01	154.12
Number of observations	4733	5210	5322	15265		

[1] Prices per DDD in Norwegian kroner (NOK).

Table 3. The effect of pharmacy margins on brand-name market shares, fixed effect results with robust standard errors.

	(1)	(2)
Producer price difference	0.489***	0.579***
	(0.038)	(0.037)
Producer price difference* Ref. pricing		0.789***
		(0.036)
Pharmacy price difference	-0.773***	-0.464***
	(0.037)	(0.039)
Reference pricing	-3.700***	0.287
	(0.589)	(0.608)
Wholesaler fixed effects	Yes	Yes
Substance fixed effects	Yes	Yes
Period fixed effects	Yes	Yes
R^2	0.210	0.234
Number ATC-groups	70	70
Number observations	15265	15265

*: p<0.10, **: p<0.05, ***: p<0.01

Table 4. The effect of pharmacy margins on brand-name market shares: Testing for asymmetric effects.

Producer price difference	0.470***
	(0.044)
Producer price difference* Brand-name margin > Generic margin	-0.159***
	(0.041)
Brand-name margin > Generic margin	2.848***
	(0.353)
Pharmacy price difference	-1.151***
	(0.044)
Reference pricing	-2.812***
	(0.457)
Constant	60.411***
	(0.871)
Wholesaler fixed effects	Yes
Substance fixed effects	Yes
Period fixed effects	Yes
R^2	0.255
Number ATC-groups	72
Number observations	15265

*: p<0.10, **: p<0.05, ***: p<0.01

Table 5. The effect of pharmacy margins on brand-name market shares, IV fixed effect results with robust standard errors (fixed effect: atc)

	(1)[a]	(2)[b]	(3)[c]
Producer price difference	0.487***	0.383***	0.338***
	(0.039)	(0.138)	(0.133)
Pharmacy price difference	-0.731***	-1.125***	-1.218***
	(0.039)	(0.349)	(0.282)
Reference pricing	-3.679***	-3.209*	-1.763
	(0.616)	(1.645)	(1.646)
Wholesaler fixed effects	Yes	Yes	Yes
Substance fixed effects	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes
Overidentification test (Hansen J statistics)	-	-	0.917
Underidentification test P-value	-	0.000	0.000
Weak identification test (Kleinberger-Paap rk Wald F statistics)	-	14.684	12.189
Number ATC-groups	58	58	58
Number observations	13328	13328	12747

*: p<0.10, **: p<0.05, ***: p<0.01

[a] Same model as Model 1, Table 3, using the subsample for which we have Danish prices.

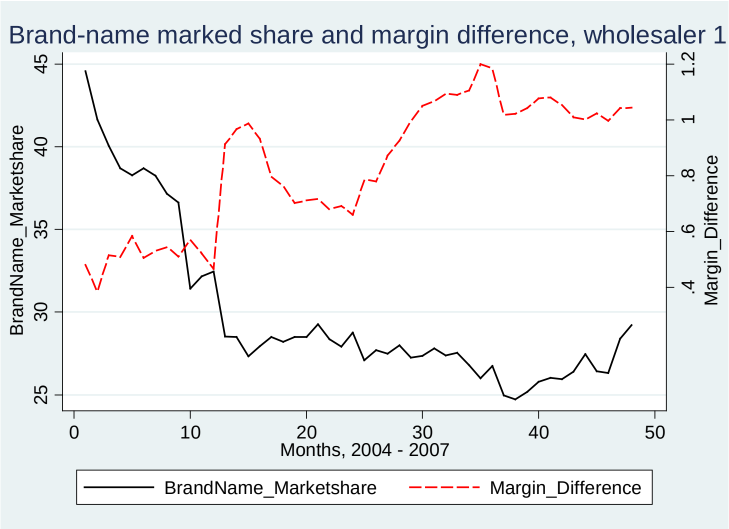
[b] In Model 2 we use the pharmacy price difference in Denmark as instrument for the pharmacy price difference.

[c] In Model 3 we use the pharmacy price difference in Denmark in *t* and *t*-1 as instrument for the pharmacy price difference.

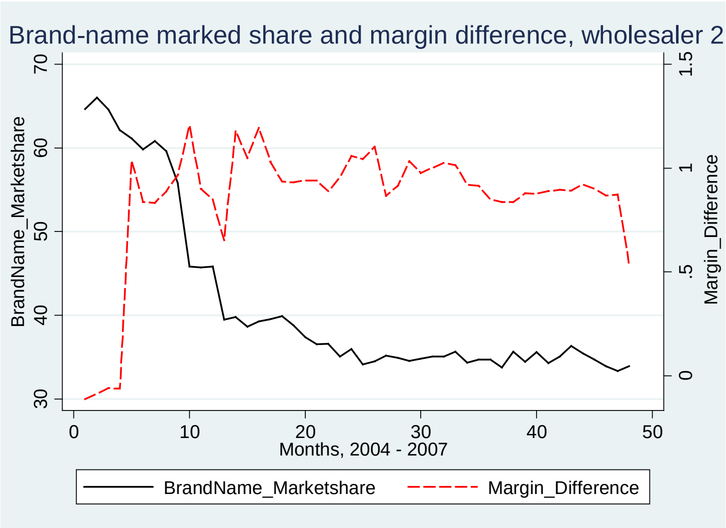
Table A.1. Descriptive statistics (prices per DDD)

ATC code	Market share	Margin difference	Margin brand name	Margin generics	Pharmacy price brand name	Pharmacy price generics	Number substitution groups	Ref. pricing	Prices Danish data	Number of obs.
A02BA02	51.25	0.33	2.23	2.56	4.19	4.19	4	1.1.2005	Yes	575
A02BA03	42.39	3.57	3.60	7.18	10.81	9.83	2	No	No	286
A02BC01	59.58	1.20	4.15	5.35	11.17	9.67	2	1.1.2005	Yes	246
A02BC03	7.78	1.96	4.34	6.31	12.11	10.20	2	1.8.2005	No	26
A03FA01	1.79	1.32	3.74	5.06	5.92	7.10	2	No	No	181
A04AA01	71.78	102.52	63.67	166.19	211.94	180.07	2	No	Yes	163
A10BA02	63.25	0.43	1.11	1.54	2.19	2.20	3	No	Yes	358
A10BB12	61.87	0.48	0.89	1.37	1.83	1.64	4	1.10.2006	Yes	241
C01DA14	34.68	0.58	1.18	1.76	2.64	2.50	1	No	Yes	144
C03DA01	13.99	0.44	1.32	1.76	3.14	2.86	3	No	Yes	432
C03EA01	26.31	-0.01	0.43	0.42	0.81	0.59	1	No	Yes	141
C07AA05	21.07	0.05	1.68	1.73	2.72	2.45	1	No	Yes	13
C07AB02	51.54	-2.40	4.65	2.25	6.67	3.47	5	No	Yes	160
C07AB03	27.25	0.28	0.82	1.10	1.56	1.52	3	1.1.2005	Yes	432
C08CA01	22.35	0.14	1.32	1.46	3.33	1.86	2	1.1.2004	Yes	274
C08CA02	25.59	0.65	0.95	1.60	2.34	1.93	2	1.1.2005	Yes	238
C08DA01	29.34	0.37	1.59	1.96	3.02	2.79	3	No	Yes	432
C09AA02	36.27	0.24	1.49	1.73	2.45	2.34	4	1.1.2004	Yes	561
C09AA03	33.28	0.55	1.41	1.96	3.04	2.84	4	1.1.2004	Yes	575
C09AA05	50.57	0.46	1.02	1.47	1.97	1.92	4	1.1.2005	Yes	425
C09BA02	37.95	0.76	1.62	2.37	3.48	3.37	1	1.1.2005	Yes	144
C09BA03	27.04	0.61	1.74	2.35	4.16	3.07	2	1.1.2005	Yes	262
C10AA01	23.81	0.57	1.15	1.72	2.50	2.40	4	1.5.2004	Yes	540
C10AA02	33.47	3.24	4.30	7.53	11.20	9.63	2	No	Yes	288
C10AA03	16.20	0.36	2.03	2.39	6.99	3.28	2	1.1.2005	Yes	219
D01BA02	10.07	4.17	6.32	10.50	20.25	12.66	1	1.8.2005	Yes	95
G03CA03	25.02	0.19	0.89	1.07	2.47	2.86	2	No	Yes	17
G03HB01	51.02	0.55	0.87	1.42	2.17	1.79	1	No	Yes	68
H01BA02	80.70	-3.59	13.00	9.41	19.76	19.82	1	No	Yes	49
J01AA02	7.52	1.08	3.63	4.71	7.26	6.85	1	No	No	68
J01CA04	29.98	0.35	5.83	6.17	12.75	9.82	4	1.5.2005	Yes	457
J01FA01	38.43	0.04	7.12	7.16	12.97	12.94	2	No	Yes	280
J01MA02	25.96	3.42	13.61	17.03	28.79	21.79	3	1.1.2005	Yes	266
J02AC01	31.12	16.93	38.44	55.37	105.15	70.29	4	1.5.2005	Yes	428
L02AE02	83.88	-0.23	13.52	13.28	48.02	48.02	3	No	No	13
L02BA01	44.41	1.12	2.00	3.12	5.21	4.49	2	No	No	238
L02BB03	76.13	18.67	14.41	33.07	49.71	43.18	2	No	No	26
L04AX03	86.61	-0.25	1.18	0.94	2.04	1.88	1	No	No	138
M01AB05	57.25	-0.41	2.80	2.39	4.46	3.68	2	1.1.2005	Yes	226
M01AC01	8.51	0.78	1.67	2.45	3.51	3.37	1	No	Yes	142
M01AC06	82.86	0.21	3.22	3.44	4.58	5.07	2	1.12.2005	Yes	103
M01AE01	4.08	0.57	2.20	2.77	3.72	3.79	3	No	Yes	319
M01AE02	10.10	0.39	1.40	1.79	2.91	2.74	2	No	Yes	150
M04AA01	35.65	0.46	1.63	2.09	2.80	2.75	2	No	Yes	286
M05BA04	13.21	1.15	2.96	4.11	10.26	4.93	2	1.12.2005	Yes	150
N02AB03	82.07	10.99	14.64	25.63	40.40	36.18	5	No	Yes	223
N02AX02	37.68	1.01	8.67	9.68	12.45	11.68	1	No	Yes	144
N02BE01	29.61	0.53	1.60	2.12	2.35	2.91	2	No	Yes	282
N02CC01	69.09	4.58	15.26	19.85	38.51	32.22	2	1.6.2006	Yes	88
N03AF01	87.62	0.09	3.61	3.70	6.88	6.44	2	No	Yes	286
N03AG01	96.84	0.05	6.33	6.39	14.86	12.70	1	No	Yes	111
N03AX09	95.94	14.43	13.66	28.09	38.13	32.95	4	No	Yes	250
N03AX11	93.14	9.98	16.36	26.34	48.02	41.49	4	No	No	144
N03AX12	85.38	6.67	15.50	22.17	35.41	32.07	3	No	Yes	292
N05AH02	37.34	4.92	7.84	12.76	21.10	19.41	2	No	Yes	286
N05AX08	27.49	0.05	10.65	10.70	31.48	20.24	4	Yes	Yes	141
N05BA01	27.40	0.20	2.41	2.61	3.41	3.25	1	No	Yes	144
N05BA12	90.73	-0.12	1.87	1.75	3.15	2.61	2	No	Yes	36
N05CD02	25.60	0.30	0.97	1.27	1.27	1.52	1	No	Yes	144
N05CF02	65.03	1.37	3.16	4.53	5.37	5.81	2	No	Yes	288
N06AB03	40.26	1.38	2.09	3.45	6.13	5.59	1	1.5.2005	Yes	144
N06AB04	19.61	-0.51	3.06	2.54	7.99	4.18	2	1.1.2004	Yes	288
N06AB05	27.62	0.48	2.45	2.92	5.61	4.24	1	1.1.2005	Yes	134
N06AB06	56.04	1.29	2.25	3.54	5.95	4.88	2	1.5.2005	Yes	85
N06AX03	88.60	0.14	2.70	2.84	4.95	5.82	3	1.3.2005	Yes	355
N06AX11	69.57	0.25	4.25	4.50	7.35	7.14	2	1.1.2005	Yes	139
N06BA04	99.87	2.41	3.39	5.80	7.07	9.15	1	No	Yes	45
R05CB01	40.85	0.10	2.45	2.55	4.22	4.23	1	No	No	144
R06AE07	23.92	-0.25	1.38	1.13	2.48	1.63	1	1.1.2004	No	143
R06AX13	39.16	0.18	1.26	1.44	3.03	2.64	1	1.1.2004	No	54

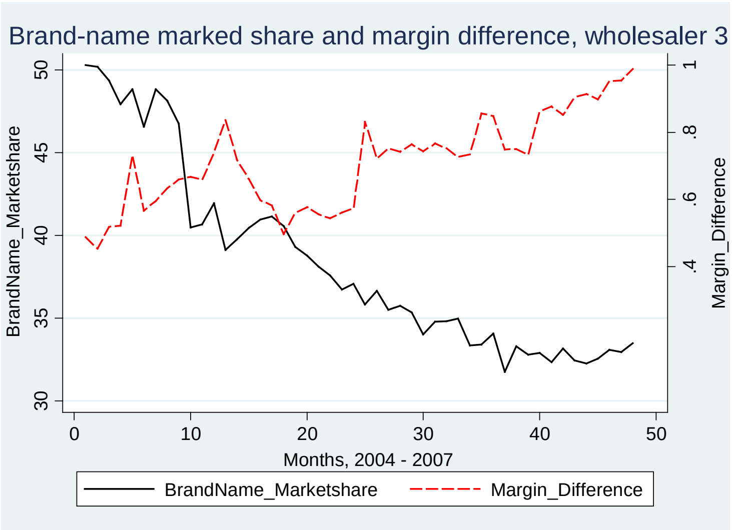
FIGURES



Brand-name marked share and margin difference, wholesaler 1
BrandName_Marketshare
Margin_Difference
25
30
35
40
45
.4
.6
.8
1
1.2
0
10
20
30
40
50
Months, 2004 - 2007
BrandName_Marketshare
Margin_Difference



Brand-name marked share and margin difference, wholesaler 2
BrandName_Marketshare
Margin_Difference
30
40
50
60
70
0
.5
1
1.5
0
10
20
30
40
50
Months, 2004 - 2007
BrandName_Marketshare
Margin_Difference



Brand-name marked share and margin difference, wholesaler 3
BrandName_Marketshare
Margin_Difference
30
35
40
45
50
.4
.6
.8
1
0
10
20
30
40
50
Months, 2004 - 2007
BrandName_Marketshare
Margin_Difference