

Do physicians' financial interests undermine generic substitution? A study of imperfect agency*

Maurus Rischatsch[†], Maria Trottmann[‡], Peter Zweifel

Socioeconomic Institute
University of Zurich
Switzerland

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Abstract

Policy makers around the world seek to encourage generic substitution (i.e. the replacement of brand-name by generic drugs) in an attempt to reduce the pharmaceutical bill. In this context, evidence from Switzerland is of considerable interest. Some Swiss jurisdictions allow physicians to dispense drugs to their patients on their own account (physician dispensing, PD). Other jurisdictions rely on prescription-based systems. PD may affect generic substitution if physicians act as imperfect agents and generic drugs differ from brand-name drugs in terms of their contribution to physician income. This research analyzes the choice between generic and brand-name drugs in both the PD and non-PD sector. In the first part, we develop a theoretical model of drug choice from which five testable hypotheses are derived. These are then tested with the help of drug claim data for three important active agents (omeprazole, amlodipine, ciprofloxacin) during the years 2005 - 2007. We find that PD significantly increases the use of the generic alternative. Moreover, generic drugs are prescribed more often to patients with high cost sharing or low incomes, pointing to consideration of the patient's financial burden by prescribing physicians. However, this effect is smaller in the case of PD, indicating imperfect agency. In sum, physicians' financial interest is found to encourage rather than undermine generic substitution.

JEL-Classification: Physician agency, prescribing behavior, drug dispensing, generic substitution, brand-name drugs

Keywords: I10, I18, I19

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[†]Contact: maurus.rischatsch@soi.uzh.ch, phone: +41 44 634 37 17, fax: +41 44 634 49 87, address: Socioeconomic Institute, University of Zurich, Hottingerstrasse 10, CH-8032 Zurich

[‡]Contact: maria.trottmann@soi.uzh.ch, phone: +41 44 634 45 96

1 Introduction

In several countries, policy makers seek to encourage generic substitution (i.e. the replacement of brand-name by generic drugs) in an attempt to reduce the pharmaceutical bill. In the United States for instance, recent proposals for health reform aim at reducing barriers to generic substitution (in the case of Medicaid, see USSCF [2009], SEC 1654). Similar initiatives exist in Australia (Van Gool [2005]), Germany (Leutgeb et al. [2009]), Sweden (Andersson et al. [2007]), and Japan (Matsuda [2008]). The popularity of these programs has been mixed, mainly because they are not aligned with prescribing physicians' (or pharmacists') incentives. Generic substitution not only requires effort and time on the part of these professionals but also entails the risk of meeting with patient resistance. Acting as a perfect agent by taking patients' total (rather than health-related) utility into account, a physician is predicted to nevertheless prescribe the generic if the savings accruing to the patient are important enough. However, if agency is imperfect, physicians' financial incentives associated with drug prescribing influence the decision in favor or against generic drug substitution as well.

In this context, evidence from Switzerland is of considerable interest. First, issues of medical malpractice surrounding generic substitution can be disregarded because (in contrast to notably the United States) malpractice litigation is extremely rare. This serves to simplify the analysis considerably because the risk of being successfully sued for prescribing a generic rather than a brand-name drug can be neglected. Second, in some Swiss jurisdictions (cantons), physicians are allowed to dispense drugs to their patients on their own account. This system will be referred to as 'physician dispensing' (PD) in the remainder of this paper. Physicians with this privilege on average derive about 28 percent of their income from PD (Hunkeler [2008]). Therefore, the financial incentives linked with the amount and structure of PD are substantial. Indeed, they might cause physicians to prescribe too many, too expensive or even clinically inappropriate drugs, resulting in an excessive drug bill possibly combined with suboptimal health outcomes. To counteract these effects, some cantons with PD require physicians to inform patients about their right to obtain a prescription to be filled by the pharmacy of their choice. Third, PD may well affect generic substitution provided physicians act as imperfect agents and given that generics differ from brand-name drugs in terms of their contribution to physician income.

In Switzerland, prescription drugs are covered by compulsory health insurance, which kicks in when the annual deductible is exceeded. Deductibles range from CHF 300 to 2,500 (€200 to 1,670 at 2007 exchange rates) and are chosen by the insured at the beginning of the year. On top of the deductible, there is a 10 percent co-payment up to a maximum of CHF 700 (€470) per year. For certain brand-name drugs, co-payment was increased to 20 percent during our observation period (2005 to 2007). As a consequence, some patients have a strengthened interest in receiving cheaper drugs, which allows to test for the degree of imperfection in physician agency.

For PD providers, generic drugs yield higher contributions to income than brand-name ones. While these contributions cannot be measured here, they likely reflect the higher margins achieved by generic producers (Liu et al. [2009]). They are zero for non-PD providers by definition. Up to present, Swiss health insurers have not been imposing generic substitution, for two main reasons. First, they have to

adhere to a uniform drug benefit, which precludes an individual insurer from drawing up its individual list containing generics. Second, they have to pay physicians according to a nationwide uniform fee schedule (see Zweifel and Tai-Seale [2009] for description and criticism) which does not provide for surcharges honoring generic substitution.

The remainder of this article is structured as follows. Section 2 contains a short review of the literature. Section 3 presents a theoretical model of physician prescribing behavior, along with a set of testable hypotheses. The empirical strategy used for hypothesis testing is explained in Section 4. Section 5 contains a description of the data. Results are shown in Section 6, while Section 7 rounds off with a summary and conclusions.

2 Literature review

To keep this survey concise, there will be no discussion of research into physician behavior in general. Rather, it will be limited to prescribing behavior. An early pertinent study is the one by Morton-Jones and Pringle [1993], who compare prescription patterns of PD and non-PD providers in the UK, finding that the share of generic drugs is lower in the PD segment. Liu et al. [2009] analyze the choice between generic and brand-name drugs in Taiwan, where PD is the dominant mode. According to them, financial incentives markedly influence this choice. Specifically, providers on a global budget are more likely to prescribe generic drugs than those reimbursed fee-for-service. Moreover, cheaper brand-name drugs (which contribute less to physician income) are more often replaced by generics than expensive ones. Finally, the 2000 reform in South Korea provides an interesting natural experiment. At that time, both drug dispensing by physicians and drug prescribing by independent pharmacists was outlawed. Descriptive statistics presented by Kim and Ruger [2008] indicate a marked increase in the market share of high-price drugs in the year following the reform.

Papers that are methodically closely related to ours are Hellerstein [1998], Coscelli [1998], and Lundin [2000]. They analyze the choice between generic and brand-name drugs in a non-PD context. Hellerstein argues that physicians bear higher information costs when prescribing generic than brand-name drugs because they collect personal experience with the brand-name rather than the generic drugs. Contrary to the hypothesis of perfect agency, she finds that prescription is not influenced by patients' insurance status and hence financial burden. However, physicians who treat a large share of patients in prepaid or Health Maintenance Organization (HMO) settings are more likely to prescribe generics (controlling for insurance status). Her panel data specification also shows that a large part of the unexplained variance can be attributed to physician type, which also holds true of Lundin's results. Interestingly, Lundin argues that physicians may want to honor R&D expenditure and pioneering effort by innovators, which adds to the psychic cost of prescribing a generic. Accordingly, he finds evidence that higher cost to the patient through co-payment increases the probability of generics being prescribed, while higher cost to the insurer does not. Coscelli emphasizes the strong brand loyalty both among physicians and patients. His policy setting, however, is special because Italian regulation imposes the same price on generic and brand-name drugs, which decreases incentives to acquire information about new generic drugs.

To our knowledge, there is no Swiss study that analyzes the effect of PD on the choice between generic and brand-name drugs, with the exception of Hunkeler [2008] who presents corroborating evidence for the hypothesis that PD leads to margin optimization or even margin maximization¹ through dispensing packages and dosages with higher official physician margins. These packages are launched first by companies entering the generics market; later, they are complemented by additional package sizes and dosages. The other studies of PD in Switzerland have focused on its impact on total physician billings or health care expenditures (HCE), respectively. An early investigation by Zweifel [1985] concluded that while PD creates incentives to keep patients out of the hospital (where different physicians are in charge as a rule), the savings achieved through a reduced rate of hospitalization fall short of the extra drug expenditure induced in ambulatory care. At a more aggregate level, Dummermuth [1993] compares two otherwise similar neighboring cantons (Lucerne with PD and Argovia without PD), finding PD to be associated with slightly higher per capita drug expenditure as well as HCE. This finding is in line with Beck et al. [2003], who relate per-capita drug expenditure to several properties of cantons, among them, their PD states. By way of contrast, Vatter and Ruefli [2003], who control for a very comprehensive set of political and socioeconomic covariates, identify a significantly negative effect of the share of PD providers on per capita HCE. More surprisingly still, Schleiniger et al. [2007] estimate a significantly negative effect of PD on drug expenditure which is robust across several specifications.

3 Theoretical model of physicians' drug choice

Because of their central role in the resource allocation in health care markets, the behavior of physicians has spawned a very rich literature (cf. McGuire [2000] for an overview). The purpose of this section is to derive testable hypotheses concerning generic drug substitution from existing theoretical models. Many of these models posit patients' health benefit as an argument in the physician's objective function. Thus, a physician (i) who prescribes a drug ($d = \{g, b\}$) to a patient (j) has utility

$$V_{ijd} = [\Pi_{id} - e_{id}] + \alpha[B_{jd} - \theta_j P_d u'(Y_j)] - \gamma[(1 - \theta_j)P_d]. \quad (1)$$

Here, Π_{id} denotes the contribution to physician income, from which effort e_{id} (in money terms) associated with prescribing is deducted. In keeping with Hellerstein [1998] this cost is higher for a generic (g) than a brand-name (b) drug. Besides the cost described in the literature, the physician might need to convince the patient that the cheaper generic drugs are not of lower quality. Without convincing effort, generic drugs might signal low quality to the patient and jeopardize the physician's reputation. For simplicity, the cost for prescribing b is normalized to zero ($e_{ib} = 0$). The second term of Equation (1) symbolizes net patient benefit, again in money terms. It equals health benefit B_{jd} minus the drug's out-of-pocket price $\theta_j P_d$, with θ_j denoting the patient's co-insurance rate and P_d , the price of the drug. The patient's utility from consuming other goods is $u(Y_j)$, which is increasing and concave in patient's income Y_j as well as additively separable from health. Since co-payment for a single drug $\theta_j P_d$ is small in our context,

¹ The difference between margin optimization and maximization is that in the first case PD providers prescribe more of small packages instead of one large package while in the second case, they prescribe a higher quantity to maximize their income.

multiplying it with $u'(Y_j)$ yields a good approximation of its impact on patient utility. Therefore, the utility loss associated with drug cost $\theta_j P_d$ is particularly high for low-income patients. In the remainder of this paper, there will be no difference in health benefits between the brand-name and the generic drugs ($B_{jb} = B_{jg}$) because we compare bioequivalent drugs, (see Section 4 for details).

As in Ellis and McGuire [1986], α symbolizes the extent to which the physician takes patient benefit into account rather than just pursuing income. For example, $\alpha = 0.5$ implies that the physician attaches twice as much weight to income (from prescribing drugs in the present context) than to patient benefit (in money terms), indicating imperfect agency. The third term of Equation (1) is motivated by agency on behalf of society at large. With high and rapidly increasing HCE being one of the top concerns of the Swiss population, promoting a cost-efficient practice style could create a *warm-glow* effect of doing what is good for society. Moreover, fear of tighter regulation in future or sanctions by insurers² might make physicians care for the cost of health care to society. Here, $(1 - \theta_j)P_d$ symbolizes the cost of the drug treatment falling on society, with $\gamma \in (0, \infty)$ indicating the importance of this concern.

The generic is prescribed if $V_{ijg} > V_{ijb}$, hence

$$V_{ijg} - V_{ijb} = [\Pi_{ig} - \Pi_{ib} - e_{ig}] + \alpha[\theta_j(P_b - P_g)u'\{Y_j\}] + \gamma[(1 - \theta_j)(P_b - P_g)] > 0. \quad (2)$$

The several aspects of physician agency can be analyzed with the help of Equation (2). To begin with, non-dispensing physicians do not obtain income from drug prescription ($\Pi_{ig} = \Pi_{ib} = 0$), while dispensing physicians are likely to receive a higher income contribution from generic than from brand-name drugs ($\Pi_{ig} > \Pi_{ib} > 0$, see Section 4).³ PD is therefore expected to increase the prescription of generic drugs. Failure to observe this indicates that physician agency – represented by α and γ in Equation (2) – is so important as to dwarf financial incentives.

Hypothesis 1: Given imperfect agency, dispensing physicians are more likely to prescribe a generic drug compared to non-dispensing physicians due to its higher income contribution.

The agency parameter α denotes the extent to which the physician takes patient benefits into account. However, there are two concepts of physician agency, viz. agency as consideration for the patient's *health benefit* (Ellis and McGuire [1986]) and agency as consideration for the patient's *total utility* from medical benefit and disposable income (Bradley and Lesu [2006], De Jaegher and Jegers [2000]). Due to bioequivalence, drug choice alters patient utility through differences in co-payments only. Therefore, only the second concept of agency, represented by the second term of Equation (2), can drive physician behavior. It leads to the prediction that generic drugs are prescribed more often to patients with high co-payment (high θ) or low income (high marginal utility of income, $u'\{Y_j\}$), than to other patients.

Hypothesis 2: To the extent that physicians are concerned about patients' total utility, generic drugs are prescribed more often to patients with higher rate of co-payment as long as the brand-name drug is more expensive than the generic, $P_b > P_g$.

² The Swiss health insurers' association (Santésuisse) scrutinizes physicians having inexplicably high cost compared to their peers and occasionally sues physicians.

³ In fact, non-dispensing physicians get a fee (TARMED) for prescribing a drug, which however does not differ between brand- name and generic drugs. This fee is therefore irrelevant to our analysis.

Hypothesis 3: To the extent that physicians are concerned about patients' total utility, generic drugs are prescribed less to patients with higher incomes because of their lower marginal utility of income.

As long as agency is imperfect, the effect of co-payment on patient's utility in second term of Equation (2) is still confounded with the difference in income contribution in the first term. However, this difference is zero for non-PD providers. Therefore, if agency motivates physicians to prescribe generic drugs to patients with high co-payment, this effect should be more marked for non-PD providers.

Hypothesis 4: Given imperfect agency, patients' rate of co-payment is more influential if the physician does not dispense drugs on his or her own account.

Many models of physician agency neglect the third term of Equation (2). If the influence of co-payment ($\theta_j(P_b - P_g)u'\{Y_j\}$) is low and $(\Pi_{ig} - \Pi_{ib})$ is zero, as applies to non-PD providers, all that remains is the (extra) effort of prescribing the generic e_{ig} . Therefore, non-PD providers who treat patients with low co-payments or high incomes have a very low propensity to prescribe generics due to their higher cost of effort. It takes agency towards the rest of society ($\gamma > 0$ in Equation (2)) to make them prescribe a generic.

Hypothesis 5: Given agency on behalf of the rest of society, non-PD providers prescribe generic drugs.

4 Econometric specification

We analyze the prescribing behavior of physician using a dichotomous discrete choice model. The dependent variable takes on the value one if the physician prescribes g and zero otherwise. Following Ben-Akiva and Lerman [1985], the physician's utility is split into a deterministic and a random component, $U_{ijd} = V_{ijd} + \varepsilon_{ijd}$, where ε_{ijd} is unobserved by the researcher. Hence, the probability of physician i prescribing drug g to patient j is

$$\begin{aligned} Pr(g = 1)_{ij} &= Pr(U_{ijg} > U_{ijb}) = Pr(V_{ijg} + \varepsilon_{ijg} > V_{ijb} + \varepsilon_{ijb}) \\ &= Pr(\varepsilon_{ijb} - \varepsilon_{ijg} < V_{ijg} - V_{ijb}), \end{aligned} \quad (3)$$

with $V_{ijg} - V_{ijb}$ given by Equation (2). It represents the probability of the random term contained in the utility function being dominated by the deterministic part, which is observed by the researcher (cf. Train [2003], Ch.2). The random term $\varepsilon_{ij} = \varepsilon_{ijb} - \varepsilon_{ijg}$ is assumed to follow the logistic distribution, resulting in the binary logit model specification. The choice probability is then given by

$$Pr(g = 1)_{ij} = \frac{1}{1 + e^{-(V_{ijg} - V_{ijb})}}, \quad (4)$$

which has a closed form that permits to analytically obtain maximum likelihood estimates and to derive odds-ratios which have a convenient and intuitive interpretation.

To calculate the choice probabilities, the systematic component of the utility function ($v_{ij} = V_{ijg} - V_{ijb}$) needs to be specified. The deterministic part of the utility pertaining to the income component of Equation (2) can be written,

$$\Pi_{ig} - \Pi_{ib} = \beta_1(m_g - m_b)PD_i, \quad (5)$$

with the difference between contributions to physician income $\{m_g, m_b\}$ interacted with a dummy that indicates physician dispensing ($PD=1$). For non-PD, the contribution to income is zero as discussed previously. Unfortunately, we cannot observe the *true* income contribution obtained by physicians. They are the outcome of an individual bargaining process between prescriber and the sales representative. However, this outcome must importantly reflect the margins the pharmaceutical company can offer to physicians, about which a few facts are known.

According to Liu et al. [2009], a drug's margin increases with market size, competition, and reimbursement price but decreases with marginal cost. Now, the small size and the high degree of protection of the Swiss pharmaceutical market affects the margins of brand-name and generic drugs in the same way. Liu et al. [2009] argue that generics have lower marginal cost than brand-name drugs because of at least two reasons. First, producers of generics do not face the expensive clinical trials that are mandatory for brand-name drugs. Second, the cost of marketing a drug is lower for imitators than for innovators, who have to propagate information about the new chemical agent. In addition, there is indirect evidence suggesting that margin are higher for generics than brand-name drugs. As to the reimbursement price of brand-name drugs, Switzerland uses an international reference price system comprising Germany, Denmark, UK, Netherlands, France, Italy, and Austria as benchmarks. In contrast, reimbursement prices for generics are calculated upon the previously determined price of the brand-name drug and have to be at least 40% lower than their originals. Santésuisse [2009] and IMS [2009] calculate price indexes for drugs with and without patent protection for Switzerland and the seven countries cited above. The two studies conclude that both, P_b and P_g are higher in Switzerland, i.e. $\Delta P_b = P_b^S - P_b^R > 0$ and $\Delta P_g = P_g^S - P_g^R > 0$ and that the international price difference is larger in the case of generics than for brand-name drugs ($\Delta P_g > \Delta P_b$) where the indices S and R indicate Switzerland and the reference group, respectively. Assuming the same cost structure for all producers, generic firms have a higher profit in Switzerland compared to the brand-name producers, $\tilde{m} = \Delta P_g - \Delta P_b$, and they have a net advantage \tilde{m} that they can use to attract physicians to prescribe their drug versions. In addition, even generics and brand-names are bioequivalent generics are perceived differently by patients. Therefore, generic firms compete for market share. This could decrease wholesale prices and increase physicians income from prescribing generic drugs.

In all, manufacturers of generic drugs likely have more leeway to offer high margins to physicians than brand-name producers. Indeed, interviews conducted with Swiss wholesalers and physicians support the notion that prescribers derive more income from generic drugs. Hence, we assume $(m_g - m_b) > 0$ and expect β_1 in Equation (5) to be positive, implying that PD increases the probability of choosing g . The information cost (e_g) in Equation (2) cannot be measured and thus will be absorbed by the random term.

A dummy for general practitioners (GPs) serves to test whether their prescribing behavior differs from that of specialists.

Co-payment borne by patients (θ_j in Equation (2)) is known from the patient's health insurance policy on the one hand and the drug-specific co-payment rate on the other. Policies differ in terms of deductibles (DED). Physicians acting as perfect agents ($\alpha \rightarrow \infty$), would want to keep patients' out-of-pocket cost low. The higher DED the more they are expected to prescribe the cheaper generic (Hypothesis 2). However, this hypothesis has to be qualified for the time before January 2006, when drug expenditure in excess of DED was subject to 10 percent co-payment regardless of type g or b . A natural experiment is provided by the policy change of 2006, when the co-payment rate for (some) brand-name drugs was increased from 10 to 20 percent while it continued at 10 percent for generics.⁴ This calls for an inclusion of time dummies for 2006 and 2007 in the regression. However, these dummies might simply reflect a trend in favor of generics as practitioners get more familiar with them. Therefore, the true test variables are $PD \cdot 2006$ and $PD \cdot 2007$; according to Hypothesis 4, their coefficients are predicted to be negative, indicating less generic substitution in the case of physician dispensing.

The price difference between the brand-name drug and the corresponding generic drugs ($P_b - P_g$) is nearly the same for all generics because the rebated prices are set by the government. Including prices in the regression analysis causes a perfect prediction of the outcome because always if the higher price is observed the outcome is zero indicating the choice of b . Hence, we replace $(P_b - P_g)$ in Equation (2) by one to take into account that the price difference between b and g is strictly positive for all combinations of package size and dosage. It acts through the co-payment coefficient (θ_j), which is proxied by DED. The interaction with PD allows to test whether co-payment is more influential in the PD mode than in the non-PD mode.

As to the third term of Equation (2), Hypothesis 5 (bearing on the role of concerns for costs to society) cannot be tested directly as the price difference ($P_b - P_g$) must be excluded from the equation for the same reason stated above. However, the following argument points to a certain influence of societal concerns. Beyond the deductible, the price difference borne by the patient is very small compared to average income. Therefore, it is unlikely that consideration for the patients' co-payment (term No.2 in Equation (2)) provides enough motivation for a significant part of non-dispensing physicians to bear the greater cost of prescribing generic drugs (e_{ig}). Therefore, the fact that the market-share of generic drugs is substantial in the non-PD sector (cf. Table 1) supports the view that $\gamma > 0$ in Equation (2), or that physicians do consider the cost borne by society at large when choosing a drug.

Health insurance policies also differ. Apart from conventional fee-for-service contracts with varying deductibles consumers can opt for a Health Maintenance Organization (HMO) or a gatekeeping alternative. We include the individual insurance policy to control for different restrictions the patients underlie. In addition, they can purchase complementary insurance that covers additional procedures (such as traditional Chinese medicine) or giving them access to a private rather than the public ward in hospitals. Both dimensions of complementary insurance likely reflect risk aversion on the part of consumers which speaks in favor of less drug substitution since the generic alternative is less well known to them. By way

⁴ This is the case for all brand-name drugs investigated in the present study.

of contrast, the presence of accident insurance is inversely related to labor force participation because it is usually provided by the employer rather than the health insurer. The hypothesis that generics are prescribed less to patients with higher income due to their lower marginal utility of income is tested by including a dummy for residence in a high-income area (see Table 2).

We complete the econometric specification by a few control variables which are shown in Table 2 but not in the regression results of Table 3. The first are patient age and gender. Also, political attitudes and institutions vary between cantons. In some, PD is widely accepted or even desired while in others, it is disputed. This calls for the inclusion of 25 cantonal dummies, with Zurich constituting the reference canton. Finally, drug substitution may also differ between dosages (in mg) and package sizes.

5 Data

5.1 Chemical agents selected

The data were provided by a major Swiss health insurer covering about 15 percent of the Swiss population and cover the years 2005 to 2007. The chemical agents selected for analysis are omeprazole (*o*), amlodipine (*a*), and ciprofloxacin (*c*).⁵ Omeprazole is used to treat gastric and duodenal abscesses; amlodipine is a calcium channel blocker used to treat angina; ciprofloxacin is used to treat specific bacterial infections. Their choice can be justified on the grounds that they have many bioequivalent competitors that are available on the Swiss market as generics.⁶ Furthermore, these agents belong to the therapeutic categories with high sales volume, causing the number of prescriptions in the data to be high (cf. Table 1). We observe 199,065 (*o*), 147,234 (*a*), and 95,745 (*c*) prescriptions where exactly one package was sold. The

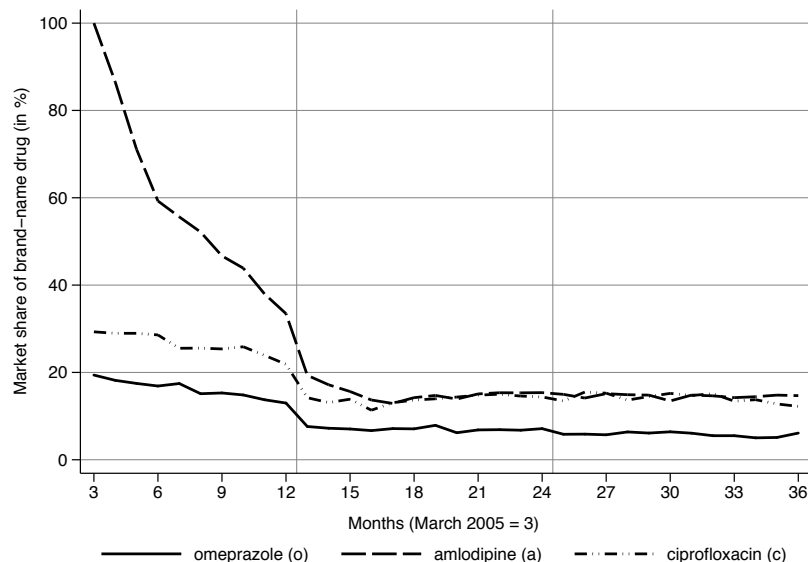


Figure 1: Market share of brand-name drug between March, 2005 and December, 2007

⁵ ATC-code: omeprazole (A02BC01), amlodipine (C08CA01), ciprofloxacin (J01MA02). For more details about the investigated agents see www.drugbank.ca/drugs.

⁶ Number of generics available on the Swiss market (2005–2007): omeprazole (11), amlodipine (12), ciprofloxacin (11).

market shares of the three brand-name drugs is depicted in Figure 1 for 33 months starting from March 2005. They dropped throughout 2005, quite likely because prescribing physicians anticipated the increase of co-payment for certain brand-name drugs from 10 to 20 percent effective January 2006. The new rate applied to brand-name drugs whose sales price was 20 percent higher than the cheapest therapeutically equivalent generic, which was the case for all three agents.⁷ As to amlodipine, the brand-name drug (Norvasc[®]) went off patent in the spring of 2005, causing it to lose its monopoly position. Since then, the generic Amlodipin-Mepha[®] has expanded its market share from 18 to 37 percent (2006) and to 38 percent (2007), respectively.

	Omeprazole		Amlodipine		Ciprofloxacin	
	PD	Non-PD	PD	Non-PD	PD	Non-PD
Market share of generics	94%	89%	82%	66%	86%	79%
Turnover of generics (in Mio. CHF)	6.3	9.2	3.7	3.5	2.0	1.7
Turnover of brand-names (in Mio. CHF)	1.0	2.8	1.5	3.1	0.4	0.6

Table 1: Market shares and turnovers of generic and brand-name drugs, March 2005 - December 2007

5.2 Physician and patient descriptors

In the data set, there are 7,522 physicians prescribing *o*, 6,016 prescribing *a*, and 7,698 prescribing *c*, respectively (the three subsets are overlapping); the share of PD varies between 44 and 54 percent, between March 2005 and December 2007. With 78 to 88 percent it is higher among GPs than specialists. The majority of physicians have their practice in urban (60-64 percent) or suburban (25-27 percent) areas. Both the 61,825 patients receiving *o* and the 58,489 receiving *c* have an average age of about 60

	Omeprazole		Amlodipine		Ciprofloxacin	
	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
Share of PD	0.44	0.50	0.47	0.50	0.54	0.50
Share of GPs	0.84	0.37	0.88	0.32	0.78	0.42
Urban area	0.62	0.49	0.64	0.48	0.60	0.49
Suburban area	0.26	0.44	0.27	0.44	0.25	0.43
High income area	0.03	0.16	0.03	0.16	0.03	0.17
Deductible (in CHF)	405	295	386	245	477	413
HMO insured	0.03	0.17	0.02	0.13	0.02	0.14
Gatekeeping insured	0.05	0.23	0.05	0.22	0.06	0.24
Private hospital insured	0.23	0.42	0.27	0.44	0.25	0.43
Complementary insured	0.87	0.33	0.89	0.31	0.90	0.31
Patient age	62	17	70	12	58	19
Patient sex (male=1)	0.38	0.49	0.48	0.50	0.40	0.49
Observations (total)	199,065		147,234		95,745	
Number of physicians/patients	7,522/61,825		6,016/27,080		7,698/58,489	

Note: Statistics based on all single observations.

Table 2: Descriptive statistics

years, and 40 percent are male. The 27,080 patients obtaining *a* have an average age of 70 years, and

⁷ Art.38a KLV

48 percent are male. The share of insured with an HMO policy varies between 2 and 3 percent, that of those with a gatekeeping policy, between 5 and 6 percent. In contrast, between 87 and 90 percent had signed up for at least one voluntary extra option to broaden the scope of reimbursed services. This strong demand for health insurance is also reflected by the fact that the median deductible is the lowest possible (CHF 300). By way of contrast, the share of consumers with private hospital coverage lies between 23 and 27 percent.

6 Estimation results

The drug choice model described in Section 4 was estimated using a pooled and a random-effects logistic regression. A likelihood-ratio test indicates that the physician-specific variance component contributes 50 to 70 percent of the total variance (see Table 3), clearly speaking in favor of the random-effects model. This is in line with Lundin [2000] who estimates a physician-specific variance component of 40 percent. Hellerstein [1998] and Coscelli [1998] mention considerable physician-specific components in the unexplained variance.

The results will be discussed in terms of odds-ratios (ORs) and their standard errors. The concept of ORs and their calculation in the presence of interaction terms can be found in Hosmer and Lemeshow [2000].

6.1 The effect of financial incentives

The coefficient of main interest in Table 3 relates to physician dispensing (PD). Here, Model *A* (with dummy variables for deductible levels) is of relevance; discussion of Model *B* (with one variable for deductible values) is reported to Section 6.2. In the case of *o*, the OR pertaining to PD is 3.6, indicating that if the drug is sold on the physician's account, generic drug substitution is 3.6 times higher no matter whether the prescriber is a GP or a specialist (insignificant interaction of PD and GP).⁸ This statement controls for the fact that the likelihood of generic substitution generally is twice as high for GPs than for specialists. This could be a sign that GPs with their lower average income are more affected by the income contribution of PD than their specialized colleagues due to a higher marginal utility of income. By way of contrast, the interaction between PD and GP yields positive and significant coefficients in the case of *a* and *c*. Here, the likelihood of prescribing a generic is not only higher in the PD mode but increases even more if the prescriber is a GP, reaching OR values of 7.8 (*o*), 6.8 (*a*), and 6.6 (*c*). Since $m_g > m_b$ (see Section 4), one can therefore conclude that physician dispensing increases the likelihood of drug substitution due to its higher contribution to physician income. The estimated ORs support this conclusion regardless of prescribers being GPs or not and for all of the three chemical substances analyzed, with the exception of specialized physicians prescribing *c*.

There may be additional reasons for dispensing physicians to choose the cheaper generic drug. First, storage causes capital user cost, which is lower for generics. Second, physicians may be better informed

⁸ The pertinent entries of Table 3 are calculated as $OR = \exp(\hat{\beta}_{PD} + \hat{\beta}_{GP} + \hat{\beta}_{PD.GP})$, where the $\hat{\beta}$'s are the coefficients belonging to the respective variables. Hence, all ORs are in comparison to non-dispensing specialists.

	Omeprazole				Amlodipine				Ciprofloxacin			
	Model A		Model B		Model A		Model B		Model A		Model B	
	OR	SE	OR	SE	OR	SE	OR	SE	OR	SE	OR	SE
Contribution to physician income:												
Physician dispensing (PD)	3.76***	(0.55)	3.58***	(0.29)	2.47***	(0.25)	3.27***	(0.19)	0.72***	(0.06)	1.77***	(0.12)
General practitioner (GP)	2.07***	(0.22)	2.07***	(0.21)	1.87***	(0.15)	2.00***	(0.15)	2.21***	(0.19)	3.59***	(0.28)
Interaction of PD and GP	1.01	(0.15)	-	-	1.47***	(0.16)	-	-	4.11***	(0.42)	-	-
Physician agency:												
Deductible of CHF 500 ^{a)}	1.37***	(0.04)	-	-	1.08***	(0.02)	-	-	1.00	(0.03)	-	-
Deductible of CHF 1,000 ^{a)}	2.67***	(0.56)	-	-	0.66***	(0.10)	-	-	1.41**	(0.21)	-	-
Deductible of CHF 1,500 ^{a)}	2.38***	(0.22)	-	-	1.34***	(0.09)	-	-	1.00	(0.05)	-	-
Deductible of CHF 2,000 ^{a)}	2.43*	(1.15)	-	-	0.96	(0.36)	-	-	1.23	(0.29)	-	-
Deductible of CHF 2,500 ^{a)}	2.54***	(0.56)	-	-	1.38***	(0.21)	-	-	1.13	(0.12)	-	-
Deductible (DED) ^{d)}	-	-	1.10***	(0.01)	-	-	1.02***	(0.01)	-	-	1.01**	(0.00)
Interaction of PD and DED	-	-	0.96***	(0.01)	-	-	1.00	(0.01)	-	-	0.99*	(0.01)
HMO contract ^{b)}	2.16***	(0.27)	2.14***	(0.27)	1.88***	(0.23)	1.84***	(0.22)	1.41***	(0.16)	1.40***	(0.15)
Gatekeeping contract ^{b)}	2.81***	(0.24)	2.69***	(0.23)	1.72***	(0.10)	1.71***	(0.10)	1.34***	(0.08)	1.33***	(0.08)
Private hospital insurance	0.66***	(0.02)	0.67***	(0.02)	0.76***	(0.02)	0.77***	(0.02)	0.93**	(0.03)	0.93**	(0.03)
Complementary insurance	1.17***	(0.04)	1.17***	(0.04)	1.14***	(0.04)	1.14***	(0.03)	1.00	(0.04)	1.00	(0.04)
Accident insurance	0.77***	(0.03)	0.76***	(0.03)	0.89***	(0.03)	0.89***	(0.03)	0.97	(0.03)	0.97	(0.03)
High-income area ^{c)}	0.46***	(0.10)	0.46***	(0.10)	0.57***	(0.09)	0.59***	(0.09)	0.91	(0.17)	0.91	(0.17)
Suburban area ^{c)}	1.12	(0.13)	1.13	(0.13)	1.00	(0.08)	1.01	(0.07)	0.98	(0.09)	1.01	(0.09)
Year 2006	3.16***	(0.08)	2.90***	(0.09)	22.50***	(0.53)	18.33***	(0.51)	3.93***	(0.12)	3.70***	(0.15)
Year 2007	3.71***	(0.10)	3.09***	(0.10)	23.76***	(0.57)	19.58***	(0.56)	3.92***	(0.12)	3.49***	(0.14)
Interaction of PD and Year 2006	-	-	1.23***	(0.07)	-	-	1.01	(0.05)	-	-	1.09	(0.07)
Interaction of PD and Year 2007	-	-	1.70***	(0.10)	-	-	0.95	(0.04)	-	-	1.23***	(0.08)
Log-likelihood at convergence:	-37,409.0		-37,416.1		-54,109.5		-55,484.0		-29,543.8		-29,650.3	
Physician-specific variance component (ρ):	0.73		0.73		0.51		0.50		0.63		0.62	
Observations (Number of physicians):	199,065 (7,522)		199,065 (7,522)		147,234 (6,016)		147,234 (6,016)		95,745 (7,698)		95,745 (7,698)	

Base categories are ^{a)}CHF 300, ^{b)}basic insurance, and ^{c)}urban area; ^{d)}DED is measured in steps of CHF 100. Additional covariates included in the regression but not shown here: 6 other area-dummies, 25 canton-dummies, a dummy indicating the second term of the year, patients' age and sex, dosage and number of pills prescribed.

Table 3: Random-effects logistic regression of drug choice (Dependent variable: generics)

about availability and prices of generics because of especially targeted marketing activities. Unfortunately, these effects cannot be analyzed with the available data. Still, the conclusion can be drawn that PD favors generic substitution. It contributes to lower pharmaceutical HCE as long as it does not go along with an increase in drug use through supplier-induced demand. This qualification is not addressed here but will be the subject of future research.

6.2 The role of physician agency

To the extent that physicians take the financial consequences of their prescriptions for their patients into account, Hypothesis 2 predicts a positive relationship between the role of co-payments and drug substitution. Patients with a higher deductible face a higher expected rate of co-payments; therefore, they should be more likely to receive the generic alternative. The evidence in Table 3 is mixed. In the case of o , the OR do increase with the deductible with one exception. The same tendency holds for a , but with one value insignificant. Finally, lack of significance is present in the case of c . These difficulties may be due to the fact that between 68 and 74 percent of the patients are insured with a deductible of CHF 300 and between 21 and 23 percent, with one of CHF 500. Replacing the deductible levels by the continuous variable DED (in Model B) is a possible solution to this problem.⁹ DED turns out in the same order of magnitude and highly significant in all three cases, leading support to Hypothesis 2.

Hypothesis 4 predicts that patients' rate of co-payment is less influential in the PD mode than in the non-PD mode. To test it, DED is interacted with PD (Model B). The interaction term is highly significant for o and weakly significant for c . The negative coefficient indicates that an increase in the deductible is less influential in the PD than in the non-PD mode. Hence, an increase in patient's deductible supports generic substitution but less strongly in the PD mode supporting Hypothesis 4 to some extent.¹⁰

Hypothesis 3 revolves around patient income, stating that richer patients are less likely to receive the generic drug. In Table 3, two indicators are used, viz. the presence of private hospital insurance and residence in a high-income area. As to the first indicator, the OR values are consistently below one (both in models A and B), indicating that generic drug substitution indeed is less likely. The same is even more markedly true for patients from high-income areas in two of the three cases (c is the exception). Therefore, there is some supporting evidence for Hypothesis 3.

One might criticize that dispensing physicians do not react to an individual patient when choosing between g and b because they have already decided what pharmaceuticals to have in their portfolio. Nevertheless, they could have an expectation about the kind of patients they will face from past visits causing them to store the drugs that best match their clientele. Further, the share of PD that is brand loyal¹¹ falls with the number of prescribed packages and is between 20 and 30 percent. Among non-dispensing physicians this share is always lower, however. This finding supports the view physician exhibit strong brand loyalty (cf. Coscelli [1998]).

⁹ Including the deductible in non-linear way does not improve the results.

¹⁰ For omeprazole, an increase in deductible of CHF 100 increases the probability of generics by 1.10 in the non-PD and 1.05 in the PD model. There is no significant difference between PD and non-PD in the case of amlodipine while the difference for ciprofloxacin is significant but very small.

¹¹ Brand loyalty means that the physician prescribed only one drug to all patients.

Finally, being HMO or gatekeeping insured increases the likelihood of generic substitution for all three chemical agents, which contradicts the findings of Hellerstein [1998].

7 Conclusions

Policy makers from around the world seek to encourage generic substitution. In this context, evidence from Switzerland is of considerable interest. Some Swiss jurisdictions allow physicians to dispense drugs to their patients on their own account (PD). Other jurisdictions rely on prescription based systems. While PD facilitates patients' access to drugs, financial incentives might cause physicians to prescribe too many, too expensive or even clinically inappropriate drugs, resulting an excessive drug bill possibly combined with suboptimal health outcomes. Moreover, PD may well affect generic substitution provided physicians act as imperfect agents and generic drugs differ from brand-name drugs in terms of their contribution to physician income. The case of Switzerland enables to investigate if dispensing physicians reveal different prescribing patterns compared to their colleagues which do only prescribe the drug and where it is sold subsequently by a pharmacy. The analyzed agents omeprazole, amlodipine, and ciprofloxacin are all agents with high turnovers and which are prescribed very often. Therefore, many generic substitutes entered the market after patent expiration.

Assuming that the unobserved margin for generics is higher than for brand-name drugs (Liu et al. [2009]) we find evidence that PD increases the likelihood of generic prescription due to financial incentives (Hypothesis 1), with the quality of the medication being unaffected because of the drugs' bioequivalence. A limitation of our analysis is that we are unable to separate pure margin effects from other differences between dispensing and non-dispensing physicians. In particular, information costs for prescribing generic drugs might be lower for dispensing physicians as they are especially targeted by sales representatives and are therefore better informed about availability and prices of drugs than their non-dispensing colleagues. Additionally, dispensing physicians have to finance their storage which binds capital and creates opportunity costs. This could lead to a preference for generic drugs that is independent of margins and information cost. We find evidence that patients' co-payment has an effect on the choice between generics and brand-name drugs (Hypothesis 2). The likelihood of receiving the generic drug version increases for patients with a higher deductible compared to the lowest level. Moreover, the deductible level has more impact if the physician does not dispense on his or her own account (Hypothesis 4).

Moreover, the odds-ratios pertaining to patient income (proxied by residence in a high-income area and the purchase of supplemental insurance for private hospitals) support the notion that wealthier patients have a higher probability of receiving brand-name drugs because the price difference between them and the generics has less of a effect due to the wealthys' lower marginal utility of income (Hypothesis 3). Finally, the market share of generic drugs is 66 to 89 percent even in the non-PD sector, pointing at physicians' consideration for the cost that are borne by society at large (Hypothesis 5).

In sum, PD may encourage generic substitution because of physician's financial incentives. This results in lower HCE for pharmaceuticals as long as PD does not fuel supplier-induced drug use, possibly combined with prescription of economically inefficient package sizes. The findings of Schleiniger et al.

[2007] of PD being associated with lower drug expenditure indicates that these side-effects fall short of neutralizing the cost savings due to generic substitution. Lowering reimbursement prices for generics to 60 percent of their brand-name counterparts as enacted in Switzerland in 2008 could therefore prove counter-productive because it serves to slow generic substitution in a world of imperfect physician agency.

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