A Welfare Analysis of Copay Coupons in Pharmaceuticals

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Abstract

Branded drug manufacturers have recently started to issue copay coupons as part of their strategy to compete with generics when their branded drugs are coming off patent. To explore the welfare implications of copay coupons, I estimate a model of demand and supply using pharmaceutical data on sales, prices, advertising, and copayments for cholesterol-lowering drugs and perform a counterfactual analysis where a branded manufacturer introduces coupons. The model allows flexible substitution patterns and consumer heterogeneity in price sensitivities and preferences for branded drugs. The counterfactuals quantify the effects of copay coupons for different assumptions about the take-up of coupons and the ability of the branded manufacturer to direct them to the most price-sensitive types of consumers. The results show that the agency problem between insurers and patients gives a branded manufacturer a strong incentive to issue copay coupons. Introducing copay coupons benefits the coupon issuer and consumers but raises insurance payments. In equilibrium, insurer spending can increase by as much as 25% even when just 5% of consumers have a coupon, with social welfare falling significantly.

1 Introduction

Coupons have long been prevalent in consumer goods, but recently they also started to play an important role in the pharmaceutical industry. The coupons distributed by drug manufacturers, called copay coupons or copay cards, reduce consumers' out-of-pocket costs of prescription drugs. Many top-selling drugs, including cholesterol fighter Lipitor, blood thinner Plavix, and blood pressure drug Diovan, started to offer copay coupons as they were coming off patent in recent years. Analysts estimate about 13% of branded prescriptions were associated with copay coupons in 2011.[1] The number of prescriptions filled with copay coupons is expected to increase approximately 15% per year.[2] Despite the fast growing use of copay coupons, little empirical work has been done to examine the welfare implications of this new strategy. In this paper, I provide a counterfactual analysis of how copay coupons affect consumer welfare, firm profits and insurance payments, using a model estimated with data from the market for cholesterol-lowering drugs.

The study focuses on a new incentive to issue coupons: the agency problem between insurers and patients in pharmaceuticals. Coupons are widely used by firms in other industries to compete for price-sensitive consumers. By distributing coupons in a market, firms can rely on consumer self-selection to achieve market segmentation and increase profits. Narasimhan (1984) shows that coupon users are more price sensitive than nonusers and firms could thus offer coupon users a lower price and raise the price for nonusers, allowing for price discrimination. The special market structure in the pharmaceutical industry gives drug manufacturers another incentive to use coupons. For prescription drugs, doctors and patients make the purchase decision and insurance companies pay for most of the drug costs. Insurance companies in the U.S. usually ask for a lower cost share from patients for less expensive drugs to reduce spending. By issuing copay coupons directly to doctors and patients, drug manufacturers can lower the out-of-pocket cost for patients and induce them to choose the drugs with coupons even though this may increase the cost to the insurance company.

[1] "Copay Cards Could Be Win-Win if All Sides Work Together," *Drug Benefit News*, July 22, 2011.

[2] "How Copay Coupons Could Raise Prescription Drug Costs by $32 Billion Over the Next Decade," Pharmaceutical Care Management Association, November 2011.

In this paper, I use counterfactuals to explore both the effects of this agency issue and how the ability to target coupons to particular types of consumer can affect the profitability of this strategy.

The welfare effects of copay coupons hinge on the substitution patterns in pharmaceuticals. To capture the key features in the markets, I estimate a model with rich substitution patterns and consumer heterogeneity in both price sensitivities and preference for branded drugs, using unique datasets on sales, advertising, and copayments. The model captures competition among drugs in various ways, including classes, molecules, forms and brandedness. Also, the model allows consumers' price sensitivities and preference for branded drugs to be drawn from a binary distribution. The consumer heterogeneity helps to explain why branded drug prices usually stay high after patent expiration. The estimates show that (1) the substitution is strongest among drugs with the same molecules, and (2) consumers who have a preference for branded drugs are less price sensitive.

The counterfactual results show that copay coupons have a large impact on social welfare even when only a small fraction of consumers get them. I simulate the outcomes of a copay coupon program introduced by the manufacturer of a branded cholesterol-lowering drug after patent expiration. I consider different assumptions about the take-up of coupons and the ability of the branded manufacturer to direct them to the most price-sensitive types of consumers. In the baseline case, coupon users and nonusers are equally price sensitive. In the targeting case, coupon users are more price sensitive. I find that, in the baseline case, the firm that introduces copay coupons would set a very low copay for coupon users and raise the full price to reap a large profit from insurers. In equilibrium, consumers gain from the lower copay by using coupons but most of the other drug manufacturers' profits shrink as the coupon program expands. Insurance payments increase by 25% when only 5% of consumers have a coupon. The net effect of copay coupons on social welfare is negative due to the large increase in insurance payments.

In the targeting case, copay coupons help to segment markets when the branded manufacturer offer coupons to more price-sensitive consumers. Most of branded drug manufacturers make a larger profit by exploiting the lower price-sensitivity of those without a coupon and charging them a higher price. The copay coupon thus mitigates price competition among branded drugs and improve their profits. At the same time, the higher prices faced by those without a coupon lowers the overall consumer welfare gain. The net effects of copay coupons on social welfare do not change much when I include the ability to target coupons to price-sensitive consumers.

The paper contributes to the literature on couponing by considering a new incentive for using coupons. Theoretical work by Holmes (1989) and Corts (1998) show that offering coupons could help price discrimination in an oligopoly setting since coupons attract price-sensitive consumers. Under certain conditions, such price discrimination will lead to higher prices and profits. Narasimhan (1984) empirically finds that coupon users are more price-sensitive than nonusers. Another empirical study by Nevo and Wolfram (2002) shows that coupons can spur price competition and lower shelf prices when they are widely available. Unlike typical coupons, copay coupons in pharmaceuticals can lead to higher drug prices because of an agency problem between insurers and patients. In this industry, consumers or patients share only a small portion of drug costs, and I show how this tends to increase the profitability of a coupon.

In addition, the structural model in the paper incorporates two important features for pharmaceutical demand estimation. First, I apply a generalized extreme value (GEV) model developed by Bresnahan et al. (1997) to capture substitution patterns along different dimensions. Arcidiacono et al. (2013) use a similar model to study the welfare impacts of me-too and generic drugs. The model has a nesting structure that allows for consumer switching based on different drug characteristics, including molecule, class, branded/generic, and form. This strength facilitates simulation of introducing copay coupons since the model captures how consumers' choices change given the new pricing strategy. Second, following Berry et al. (2006) in their analysis of airline industry, I consider two types of consumers who differ in their price sensitivities and choice sets. The consumer heterogeneity could help to explain branded drugs' pricing after they lose patent protection. Also, the consumer heterogeneity makes it possible to separate the motivations of couponing. In the two-type framework, I can control for coupon users' type and examine how the agency problem between insurers and patients would affect equilibrium prices when copay coupons are used.

Finally, the unique datasets used in the demand estimation of this paper cover major aspects in pharmaceuticals, including prescription drug sales, physician advertising, direct-to-consumer advertising (DTCA), and copayments. Jayawardhana (2013) is one of the few empirical studies that use these rich data in demand estimation for pharmaceuticals. Most of the other papers in pharmaceutical literature use a single source of advertising to represent the marketing from drug manufacturers and/or include full prices in demand. In the case of cholesterol lowering drugs considered in this paper, DTCA and physician advertising both play an important role in marketing and adding them can help to explain substitutions among drugs. Additionally, copayments are the actual prices faced by consumers. Using full prices in demand estimation would underestimate the price coefficient. The data on copayments also helps to build the relationship between full prices and copayments and facilitate counterfactuals in which firms change full prices to affect insurance copayments and demand for drugs when copay coupons are introduced.

The rest of the paper is organized as follows. Section 2 provides industry background and relevant information about copay coupons. Section 3 describes data. Section 4 develops models for demand, supply, and copayments. Section 5 discusses estimation strategies and estimation results. Section 6 presents counterfactuals for introducing copay coupons under two scenarios. Section 7 concludes.

2 Copay Coupons in Pharmaceuticals

Copay coupons are instantaneous rebates to patients usually offered by branded drug manufacturers. They are distributed on drug manufacturers' websites or provided by sales representatives through doctors' offices. The coupons reduce patients' copayments when they fill a prescription at pharmacies. Suppose one-month supply of a branded drug costs $150 and its generic alternative costs $30. A patient's insurance copayments for the two drugs are

$40 and $10, respectively. Without a copay coupon, the patient, who is indifferent between the branded drug and generic alternative, would choose the less expensive generic and the insurer pays $20 for the prescription. If the branded drug manufacturer gives a copay coupon that reduces the out-of-pocket cost to $5, the patient would choose the branded drug and the insurer must pay $110. In this case, the branded drug manufacturer helps the patient to pay $35 for the copayment and earns $110 from the insurer.

Many branded drug manufacturers started to offer copay coupons as their drugs were losing patent protection in recent years. In December 2010, Pfizer launched a "Lipitor for You" program which allowed patients to pay as little as $4 for a month's supply of Lipitor, the best-selling drug in the history of pharmaceuticals. One month's supply of Lipitor normally has a retail price of $150 and the copay for generic Lipitor is about $10. Thus, the $4 copay program offered by Pfizer was very attractive, helping to keep about one-third of Lipitor's prescriptions within five months of its patent expiration in late 2011.[3] Many top-selling drugs followed the strategy as they were coming off patent, including blood thinner Plavix and blood pressure drug Diovan. Spending on copay coupons in 2011 is estimated to be $4 billion.[4] This is close to the aggregate spending on direct-to-consumer advertising ($4.3 billion) and accounts for two percent of gross branded drug sales in U.S.

Copay coupons can help to combat generic entry by lowering the costs for patients and influencing doctors' decisions. In March 2013, 53.5% of the 374 copay coupons found from www.internetdrugcoupons.com, a large drug coupon website, are for branded drugs with generic alternatives.[5] As many blockbuster drugs are going off-patent by 2015 and few new drugs are available to replace the revenue lost from patent expiration, branded drug companies have worked hard to retain their revenue after generics enter the market. Copay coupons can help to price compete with generics without cutting the full branded prices. Using copay coupons, branded drugs need to pay part of the out-of-pocket cost for patients. Since

[3] "New Coupons Aim To Keep People Off Generic Drugs," Associated Press, August 20, 2012.

[4] `http://www.pharmexec.com/pharmexec/article/articleDetail.jsp?id=755091`

[5] Among the copay coupon programs, 53.5% are from drugs with within-class generic alternatives, 8.3% are from drugs with FDA-approved therapeutic equivalents, and 38.2% are from drugs without lower cost alternatives. Source: Ross, J. S., and A. Kesselheim (2013): "Prescription-Drug Coupons - No Such Thing as a Free Lunch," *The New England Journal of Medicine*, 369, 1188-1189.

patients' share is usually less than one-third of full drug price, the benefit from insurance payments usually exceeds the cost of copay coupons. In addition, a report by Credit Lyonnais Securities Asia (CLSA) revealed that that 80% of physicians polled were more likely to prescribe a drug with a copay coupon.[6] Therefore, copay coupons could effectively influence doctors' decision to use brand-name drugs over generics by paying part of the copayment for patients.

The "shadow claims system" of copay coupons further contributes to their popularity. In the shadow system, prescription information is first sent to a pharmacy benefit manager (PBM), who processes prescription drug claims for employers, for adjudication. After the PBM adjudicates the prescription and sends the copay information back to the pharmacy, copay coupon programs reduce the copay for the coupon user. Thus, copay coupon programs are invisible to PBM's or insurers.[7] Because of the invisibility of copay coupon programs, insurers could not reject the use of copay coupons unless they remove the drug completely from their prescription drug list.

Copay coupons are banned in federal health programs, including Medicaid and Medicare, because they are considered illegal kickbacks that encourage unnecessary spending.[8] In the commercial market, Massachusetts had been the only state that prohibited copay coupons. However, in 2012 the Massachusetts government loosened the restriction by allowing manufacturers of branded drugs without competing generic equivalents to offer coupons.

3 Data

Data are obtained from four sources. First, data on pharmaceutical sales are provided by IMS Health. In the data, I observe national retail dollars and unit sales of each molecule/form/strength combination at monthly frequency from January 2003 to August

[6] http://www.uhc.com/pharmacy/news_and_updates/drug_copay_coupons.htm

[7] "How Copay Coupons Could Raise Prescription Drug Costs by $32 Billion Over the Next Decade," Pharmaceutical Care Management Association, November 2011.

[8] The prohibition does not apply to the insurance sold through the online health insurance marketplaces which began on October 1, 2013. The United States Department of Health and Human Services held that the insurance offered through the exchanges is not federal health care program subject to the prohibition.

2011. Drug manufacturers and whether a drug is branded or generic are also provided in the data. Second, physician advertising data from Encuity Research contain monthly product level spending on detailing, medical journal advertising, and events and meetings.[9] Direct-to-consumer advertising data are obtained from Ad$pender database from Kantar Media. In the data set, they have monthly advertising spending for each product/media/market combination from January 2003 to August 2011. The media include television, radio, magazines, newspaper, internet and outdoor. There are national advertising as well as local advertising. For most of the drugs in the research, the spending is concentrated on national advertising. Thus, local advertising is ignored. Finally, copayment data are obtained from the MarketScan Research Databases through National Bureau of Economic Research (NBER). The files have prescription level claim data on copayments and full prices from about 150 employers, covering 40 million enrollees in the United States.[10]

I focus on the markets of HMG-CoA reductase inhibitors (statins), the major cholesterol medicines or lipid regulators. There are several reasons to look at this market for research on copay coupons. First, the cholesterol drug market is large. Cholesterol drugs were the third largest therapeutic class by spending in 2011, at 20.1 billion US dollars. There were over 260 million prescriptions filled in 2011 and nearly 20 million Americans regularly used a cholesterol medicine.[11] Second, cholesterol medicines ranked first in spending on direct-to-consumer advertising among all therapeutic classes in years 2009 to 2011. Cholesterol drug manufacturers together spent on average 500 million dollars each year on DTCA.[12] This is evidence that firms in the cholesterol drug market care a lot about communication with consumers. Finally, entry of generics further intensified competition and adds to variation in pricing and advertising.[13] Two of the ten statins lost patent protection during the sample period and their generic versions entered right after their patent expiration. Entry of generic

[9] Free sample data are available only after January 2007, so they are ignored.

[10] The data only cover privately insured individuals and do not include prescription drug claims from Medicare or Medicaid. The data limitation may lead to overestimated copayments for an average patient since generic utilization is higher in Medicare Part D plans.

[11] *The Use of Medicines in the United States: Review of 2011*, IMS Institute.

[12] Source: Kantar Media A$Spender Database

[13] In this paper, entry is treated as exogenous. Adding a model of entry would complicate the analysis because a dynamic model would be needed for entry and this is beyond the scope of the paper.

drugs dramatically changes the competitive environment, creating an opportunity to learn how consumers switch from branded drugs to generics.

The statins in the sample and their relevant facts are summarized in Table 1. The variations in class, molecule, form, and whether generics are available serve as the basis for modeling substitution among drugs. There are two classes: statins and statin combinations. Statins entered the market early in 1987 and statin combinations are relatively new as a treatment for high cholesterol. Statins combined with other molecules are treated as a different class since the combinations may have different effects on patients. Also, drugs in the classes come in three forms: tablet, sustained-action tablet, and capsule. Sustained-action is a mechanism that helps to dissolve a drug over time and release it more slowly and steadily into bloodstream so that a patient could take drugs less frequently. Because of the convenience from this mechanism, some consumers may prefer drugs in sustained-action tablet to drugs in tablet or capsule. Finally, three of the statins (Zocor, Pravachol and Mevacor) have generic alternatives. They all have a maximum number of generic equivalents greater than ten, implying severe within-molecule competition after patents expire. I treat the generics from different firms as separate products in the model for demand and supply.[14]

Note that Pfizer launched the "Lipitor for You" program and started to distribute copay coupons in December 2010. There are nine months of sales data in which some prescriptions for Lipitor may be associated with copay coupons. Since coupon use is not observable in the data, I do not consider the impacts of Lipitor's copay coupons in the estimation.

3.1 Sales and Prices

Figure 1 presents sales measured by patient-days. To make drugs with different strengths comparable in sales, I transform unit sales into patient-days by dividing the total number of

[14]Some of the generics are "authorized generics," which are approved by FDA as brand-name drugs but marketed as generic drugs. According to a FTC report on authorized generics, pricing decisions by outside licensees typically are independent of the brand. The report also provides evidence of competition between authorized generics and their branded counterpart. In my data, all authorized generics are independent licensees. Thus, I treat them as competitors to the branded drug with the same molecule.

milligrams sold by the recommended daily dosage.[15] The market grows over time with introduction of new drugs as well as entry of generics. The three major drugs are atorvastatin (Lipitor), simvastatin (Zocor), and rosuvastatin (Crestor). Zocor loses its patent protection in mid 2006. Within half a year after the patent expires, generic simvastatin quickly takes over the market of Zocor and expands the overall statin share. Atorvastatin (Lipitor) dominates the market until late 2006 when many generic simvastatins are available. The steady growth in the market share of Crestor, rolled out in 2003, also contributes to drops in the other branded drugs' sales.

Figure 2 shows prices per patient-day. All prices are adjusted to January 2003 dollars. Most branded drugs have a price between one and three dollars per patient-day. Prices are quite stable for drugs under patent protection. In contrast, drugs with generic alternatives experience some price changes. Prices of branded simvastatin (Zocor), pravastatin (Pravachol) and lovastatin (Mevacor) tend to fall slightly as generics just enter but they move back to the original level when generic competition intensifies and generic prices become very low. The pricing pattern suggests that branded drugs would price compete with generics for the general consumers when there are only a few generics available. As many generics enter the markets, they choose to concentrate on the consumers with a strong preference for branded products.

Table 2 presents the summary statistics for the full sample as well as the subsamples for branded drugs both with and without generic equivalents, and generics. Each observation is a combination of month, molecule, brandedness, form, and manufacturer. Generics from different manufacturers are treated separately. On average, branded drugs without generic equivalents have the highest price and largest market share. The market share of branded drugs becomes much lower after generic entry while their prices are only slightly lower than before generics enter. Generic prices are on average one fourth of branded prices. An average generic accounts for 0.5% of market, compared to 2% for an average branded drug under patent protection. This shows that even if there are many branded drugs in the markets,

[15]The daily recommended dosage data are obtained from Clinical Pharmacology, an online database for drug information widely used by hospitals and retail pharmacies in US.

patents still protect drugs from severe competition. After a patent expires, a large number of generic entrants simply take over the market from branded drugs.

3.2 Advertising

Figure 3 demonstrates the patterns of advertising to physicians and Figure 4 for direct-to-consumer advertising. Spending on advertising to physicians is the aggregate spending on detailing, journal advertising, and events and conferences. Direct-to-consumer advertising spending is the sum over national advertising spending through various channels. Also, only the four most advertised branded drugs are included because the advertising spending by the other products is relatively small. First note that physician advertising and DTCA spending for branded rosuvastatin is very large in the first few months of rollout to inform doctors and consumers of the existence of the new drug. Second, branded simvastatin and pravastatin start to cut advertising spending as their patent expiration dates approach. Their physician advertising spending drops to a very low level after generics become available. The drop in DTCA spending happens about one year before their patents expire. Table 2 shows that on average branded drugs' advertising spending is only 6% of the advertising spending before generics enter. These patterns imply that branded drugs have little incentive to invest in advertising after patent expires since consumers and physicians encouraged by advertising to use the drugs may choose the less expensive generic versions. Also, the patterns are consistent with the strategic investment story discussed in Ellison and Ellison (2007). Branded drug manufacturers have an incentive to reduce advertising to make a market less attractive to generic entrants although it is not clear that the strategy is effective in this case.

4 Model

In this section, I discuss the models of demand, supply, and copayments. I consider a random-coefficient discrete-choice demand model. The error structure is based on the model used in Bresnahan et al. (1997), which allows unobserved preferences to be correlated across multiple nests. By differentiating products along multiple dimensions, we can capture rich substitution patterns among drugs. To capture consumer heterogeneity in their preference for branded drugs, I use a simple two-type version of the random-coefficient model following Berry et al. (2006). Also, I construct a static supply side model to estimate marginal costs, identify some parameters for consumer heterogeneity, and to more precisely estimate the parameters from demand. Finally, the model for copayments builds the relationship between full price and out-of-pocket costs for consumers.

Before discussing the model set-up, it is worth being clear about a couple of limitations of the current analysis. First, like most of the literature on pharmaceutical demand, I assume that doctors and patients jointly make decisions to maximize utility. Thompson (1993) discusses that conflicts of interest between physicians and patients could arise from gifts given by drug companies to physicians, physicians' risk sharing in health maintenance organizations and hospitals, research on patients, etc. In recent years, government intervention and self-regulation by pharmaceutical industry have aimed to alleviate the problem and the conflicts of interest could be less serious.[16] Second, I do not try to consider how the use of coupons affects the entry of either branded or generic drugs. This could be addressed by adding an endogenous entry model to the current framework, but I leave this type of question to future work.

4.1 Demand

In the demand model, a consumer makes a discrete choice given a set of product characteristics. The consumer here refers to the combination of patients and doctors. I assume that they make joint decisions to maximize utility and ignore the possible principal-agent problem.[17] A product here is a combination of molecule, form, brandedness, and firm.

[16] For example, The Physician Payments Sunshine Act, effective on August 1, 2013, requires manufacturers of drugs that participate in U.S. federal health care programs to report certain payments and items of value given to physicians. In 2008, Pharmaceutical Research and Manufacturers of America (PhRMA) strengthened the Code on Interactions with Healthcare Professionals to ensure that biopharmaceutical marketing practices comply with the highest ethical and professional standards.

[17] Lack of micro-level data on prescribing prohibits me from distinguishing the two roles in decision making.

There are four dimensions along which products are differentiated: classes, branded/generic, molecules, and forms. As shown in Table 1, drugs of different molecules can be classified into statins and statin combinations. Three molecules have generic versions and two molecules have multiple forms.

An individual in period t chooses from J_t products, indexed $j = 1, 2, ..., J_t$. The indirect utility consumer i obtains from j in period t is

$$u_{ijt} = \alpha_i p^c_{jt} + x'_{jt}\beta + \mu_j + \xi_{jt} + \epsilon_{ijt}, \tag{1}$$

where p^c_{jt} is the copay for product j in time t, and x_{jt} is a set of time-varying observed product characteristics. μ_j is product fixed effect and ξ_{jt} is a time-varying component that captures unobserved demand shocks. Idiosyncratic taste parameter, ϵ_{ijt}, is assumed to be independent across consumers but correlated among products. The mean utility for product j in time t is $\delta_{jt} = x'_{jt}\beta + \mu_j + \xi_{jt}$. Consumers have an outside option, which includes non-drug treatments and no treatment. I normalize the utility of the consumer from this outside option to zero because I cannot identify relative utility levels.

The vector x_{jt} has several time-varying components that may affect consumer utility. First, I include the logarithm of physician advertising spending by product j in time t, $\log(1 + AD_{jt})$, and the logarithm of DTCA spending, $\log(1 + AC_{jt})$. Allowing advertising spending to enter directly to consumer utility, I assume that the two types of advertising have persuasive effects.[18] Second, to consider the spillover effects of advertising, I add physician advertising and DTCA spending from the other drugs with the same molecule, $\log(1+ADOT_{jt})$ and $\log(1+ACOT_{jt})$. These two variables help explain the branded drugs' advertising pattern close to patent expiration date, since free-riding of generics on branded advertising would reduce the incentive to invest in advertising. Third, I include time dummies for each period and time-since-entry dummies for each of the first twenty four months after drug entry. Time dummies capture the change in the quality of outside goods and time-

[18]While literature on DTCA suggests that DTCA is more informative than persuasive, allowing the informative role of DTCA can complicate the model and largely increase computational burden. The DTCA here can be better viewed as a variable to control for time-varying product characteristics.

since-entry dummies handle increasing consumer awareness of the existence of a new drug.

I model two types of consumers who differ in their choice sets and price sensitivities. High type consumers are assumed to have a strong preference for branded drugs and they consider only branded drugs. Low type consumers make a choice among all drugs available.[19] The price coefficient α_i is

$$\alpha_i = \begin{cases} \alpha^H & \text{if i is high type} \\ \alpha^L & \text{if i is low type} \end{cases}. \tag{2}$$

The consumer heterogeneity helps explain price differentials between branded and generic drugs. In the absence of consumer heterogeneity, the high price of branded drugs after patent expiration would be captured by a jump in marginal cost, which is not consistent with intuition. Moreover, estimating two types of consumers enables me to explore how coupon targeting affects welfare changes from copay coupons in the counterfactual in which coupon users are all low type.

To allow ϵ_{ijt} to be correlated among products, I follow McFadden et al. (1978) and assume the unobserved idiosyncratic parameter has a generalized extreme value (GEV) distribution with multivariate cumulative distribution function

$$F(\epsilon_{i0t}, \epsilon_{i1t}, ..., \epsilon_{iJt}) = \exp\left[-G\left(e^{\epsilon_{i0t}}, e^{\epsilon_{i1t}}, ..., e^{\epsilon_{iJt}}\right)\right],$$

which implies that the market share of product j in time t from the high type is given by

$$s_{jt}^H = \frac{e^{\delta_{jt}+\alpha^H p_{jt}^c} G_j^H\left(e^{\delta_{i0t}}, e^{\delta_{i1t}+\alpha^H p_{1t}^c}, ..., e^{\delta_{iJt}+\alpha^H p_{Jt}^c}\right)}{G^H\left(e^{\delta_{i0t}}, e^{\delta_{i1t}+\alpha^H p_{1t}^c}, ..., e^{\delta_{iJt}+\alpha^H p_{Jt}^c}\right)}, \tag{3}$$

where G_j^H is the partial derivative of G^H with respect to the j^{th} argument. Similarly the

[19] The assumption on the consumer heterogeneity in choice sets is equivalent to including a dummy variable in high type's indirect utility and forcing the coefficient on the dummy variable to be negative infinity.

market share of product j in time t from the low type is given by

$$s_{jt}^L = \frac{e^{\delta_{jt}+\alpha^L p_{jt}^c} G_j^L \left(e^{\delta_{i0t}}, e^{\delta_{i1t}+\alpha^L p_{1t}^c}, ..., e^{\delta_{iJt}+\alpha^L p_{Jt}^c}\right)}{G^L \left(e^{\delta_{i0t}}, e^{\delta_{i1t}+\alpha^L p_{1t}^c}, ..., e^{\delta_{iJt}+\alpha^L p_{Jt}^c}\right)}. \tag{4}$$

Following Bresnahan et al. (1997), I specify G^H and G^L as

$$G^H \left(e^{\delta_{i0t}}, e^{\delta_{i1t}+\alpha^H p_{1t}^c}, ..., e^{\delta_{iJt}+\alpha^H p_{Jt}^c}\right) = e^{\delta_{0t}} + \sum_l a_l \left[\sum_k \left(\sum_j I(j,k,l) BRAND_j e^{\frac{\delta_{jt}+\alpha^H p_{jt}^c}{\rho_l}}\right)^{\rho_l}\right] \tag{5}$$

$$G^L \left(e^{\delta_{i0t}}, e^{\delta_{i1t}+\alpha^L p_{1t}^c}, ..., e^{\delta_{iJt}+\alpha^L p_{Jt}^c}\right) = e^{\delta_{0t}} + \sum_l a_l \left[\sum_k \left(\sum_j I(j,k,l) e^{\frac{\delta_{jt}+\alpha^L p_{jt}^c}{\rho_l}}\right)^{\rho_l}\right], \tag{6}$$

where $I(j,k,l)$ is an indicator variable taking on the value of one if product j has the k^{th} value of the l^{tj} characteristic and ρ_l is the nesting parameter along the l^{th} dimension. $BRAND_j$ is an indicator equal to one if j is a branded drug and zero otherwise. The scaling parameter a_l is defined as

$$a_l = \frac{1-\rho_l}{\sum_{l=1}^{L}(1-\rho_l)}.$$

The market share for product j in time t is the weighted average of the market share from the two types. Assume high type consumers account for λ_t fraction of the market in time t. The market share for product j in time t can be expressed as

$$s_{jt} = \lambda_t s_{jt}^H + (1-\lambda_t) s_{jt}^L. \tag{7}$$

4.2 Firm Behavior

Assume there are $f = 1, 2, ..., F_t$ firms in period t competing in a Bertrand-Nash game. Firm f produces a subset of J products, J_f. The profit for firm f, omitting the time subscript, is

$$\Pi_f = \sum_{j \in J_f} (p_j - mc_j) M s_j(p, AC, AD, \xi; \theta) - AD_j - AC_j, \quad (8)$$

where s_j is the market share of product j, mc_j is the marginal cost of product j, and M is the market size. AD_j and AC_j are the spending on advertising to consumers and physicians, respectively. The marginal cost is assumed to be

$$\log(mc_{jt}) = \eta_j + g(t) + h(\tau_{jt}) + \omega_{jt},$$

where η_j is the product fixed effect, $g(t)$ the function for time trend, $h(\tau_{jt})$ the function for time since entry, and ω_j is the (time-varying) unobserved cost shocks.

Given the prices, product attributes, advertising spending and marginal costs, firms simultaneously choose prices to maximize profits.[20] The first order condition with respect to price is given by

$$s_j + \sum_{k \in J_f} (p_k - mc_k) \frac{\partial s_k}{\partial p_j} = 0. \quad (9)$$

4.3 Copayments

The price faced by insured consumers is a small share of the full price. In the United States, insurance plan enrollees may pay a fixed amount for each prescription regardless of the drug cost (copayment), or a percent of the prescription drug cost (coinsurance). The tier pricing system designed by insurance companies usually puts less expensive drugs in lower tiers and requires a smaller copayment or coinsurance from enrollees. For example, a typical three-tier system has generics in tier one, branded drugs without generic substitutes in tier two, and branded drugs with generic substitutes in tier three. According to the 2011 Annual Survey by Kaiser Family Foundation, 72% to 85% of covered workers have copays for drugs listed in the first three tiers and 7% to 11% of covered workers have coinsurance.[21]

[20] I do not consider the decision on advertising in firms' problem and assume that there is no strategic interaction in advertising. In the counterfactuals later, I do not solve for new advertising levels either.

[21] http://kff.org/health-costs/report/employer-health-benefits-annual-survey-archives/

To have a model that nests copayment and coinsurance for an average consumer, I assume

$$\log(p_{jt}^c) = \gamma_0 + \gamma_1 \log(p_{jt}), \tag{10}$$

where p_{jt}^c is the cost shared by the consumer for product j in period t and p_{jt} is the full price for product j in period t. The first term (γ_0) is the fixed amount and the second term $\gamma_1 \log(p_{jt})$ is the cost as a part of the full price. The model thus incorporates the two types of cost-sharing systems. In addition, the log-log model would be able to accommodate the fact that a high full price charged by drug manufacturers would not be proportionally passed on to enrollees. The marginal growth of their costs will be diminishing for $\gamma_1 \in (0,1)$. Similarly, a very low full price would not make enrollees' out-of-pocket costs proportionally lower since they are responsible for a basic payment for each prescription. As illustrated in Figure 5, the log-log model predicts the copayment for consumers by pushing down a high full price and moving up a low full price.

5 Estimation

The estimation of demand parameters closely follows Berry et al. (1995, 2004) and Nevo (2000). I assume that the demand and pricing unobservables are mean independent of a set of instruments at the true parameters. That is, $E\left[\xi_j(\Theta_0) \mid Z\right] = E\left[\omega_j(\Theta_0) \mid Z\right] = 0$. Using the contraction mapping suggested by BLP, I am able to compute ξ_j given a set of parameter values and observed market shares:[22]

$$\xi_{jt} = \delta_{jt}(s, \theta) - x_{jt}'\beta - \mu_j. \tag{11}$$

The marginal cost is computed from the first order condition:

$$mc = p - \Delta(\theta, \delta)^{-1} s(\theta, \delta) \tag{12}$$

[22] Because of the model specifications, the contraction mapping here is slightly modified and the proof of invertibility is put in the appendix.

where $\Delta_{j,k} = -\partial s_k/\partial p_j I_j$ with I_j equal to one if j and k are produced by the same firm. Then we can derive

$$\omega = log(p - \Delta(\theta, \delta)^{-1} s(\theta, \delta)) - \eta - g - h(\tau). \tag{13}$$

Estimation of the parameters is undertaken by the generalized method of moments (GMM). I minimize the objective function of $\Lambda' Z W Z' \Lambda$, where W is the weighting matrix. Let Z_ξ be the instruments for ξ and Z_ω be the instruments for ω. The sample moments are (the time subscript are suppressed)

$$Z'\Lambda = \begin{bmatrix} \frac{1}{J}\sum_j Z_{\xi,j}\xi_j(\alpha, \beta^{AC}, \beta^{AD}) \\ \frac{1}{J}\sum_j Z_{\omega,j}\omega_j(\alpha, \beta^{AC}, \beta^{AD}, \eta_j) \end{bmatrix}. \tag{14}$$

The choice of instruments for price and advertising relies on the identifying assumption used in Bresnahan (1987) and Berry et al. (1995). I assume the location of each drug in product space is exogenous and a drug's markup, which is a function of prices and advertising levels, is correlated with its relative isolation in the product space. Since I do not include product characteristics in the indirect utility, rather than summing up the characteristics of own products and the other firms' products as in BLP, I follow Arcidiacono et al. (2013) and count the number of products in a category defined in various ways. Specifically, I use the number of molecules for the same form, number of molecules of the same form in the same class, whether generics are present in the same form, whether generics are present in the same molecule, number of generics present of the same molecule, number of generics present of the same form, and number of generics present of the same form in the same class.[23]

I discuss identification in an intuitive way. Nesting parameters (ρ_l's) are identified from changes in aggregate market share for each nest when the number of products in a nest varies. Take as an example the case of a nested logit model with molecules as nests. If

[23]The F-statistics based on usual standard errors from the first-stage regressions of endogenous variables on the instruments range between 29 and 113, suggesting that the instruments are relevant.

the nesting parameter is one, the model reduces to a simple logit model. The market share would be roughly the same for each drug if they share similar product characteristics. If the nesting parameter is zero, drugs of the same molecule are perfect substitutes. Adding one drug to a molecule nest or changing the price of a drug in a nest does not affect the market shares of drugs in the other nests.

Identification of the fraction of high type consumers (λ) relies on the first order conditions with respect to prices on the supply side. If λ is zero, more competition from generics will drive branded drugs' prices down. If λ is one, there will be zero market share for generics and branded drugs' prices will not change as generics enter. Thus, firms' pricing decisions help to identify the fraction of high type consumers. Once λ is identified, the price coefficients for each type (α^H and α^L) could be identified from variations in prices of both branded and generic drugs. Identification of the linear parameters is more straightforward. Variations in advertising spending across products and over time helps to identify their coefficients in the demand model.

5.1 Results

Table 3 shows the results for copay estimation from 2003 to 2009. The estimates for each year are the weighted average over plans based on the empirical distribution of the number of plan enrollees. The estimates for the two parameters are similar over the years. They are all significant at 5% level and the large sample size makes the standard errors small. Those estimates are used to predict the copayments for demand estimation and counterfactuals. For the years after 2009, I use the estimates for 2009 to predict the copayments.

Table 4 presents the estimates and standard errors for nesting parameters and the most important linear parameters in demand. Most estimates are statistically significant at 5% level. The nonlinear parameter estimates reveal how consumers substitute among the products. The estimated nesting parameter for molecule is about 0.56 while the other nesting parameter estimates fall between 0.63 and 0.67. This means that within-molecule substitution is the strongest, which is consistent with the sudden changes in the market share of branded drugs when their generic alternatives become avaiable. The estimate for the fraction of high type consumers is about 14%. The price coefficient for high type consumers is estimated to be -8.7, compared to -27.2 for low type consumers. Obviously, a non-trivial portion of consumers has a strong preference for branded products and they care much less about the drug copays than do low type consumers.

The large price coefficients do not mean that we should expect price elasticities to be extremely large. Use of copay rather than full price in the demand model generates larger price coefficients since copays are a small share of full price. According to the copay estimates, one dollar increase in full price results in an average of \$0.21 increase in branded copay and \$0.26 increase in generic copay. This implies that insurers would pass only one fourth of drug cost increase on to consumers and thus the price elasticities shown later would generally be small.

Linear parameter estimates show the effects of advertising and increasing consumer awareness since a drug's rollout. Recall that I include in the indirect utility the logarithm of advertising spending. Therefore, in interpreting the estimates for advertising parameters, we need to control for the advertising levels. The estimate for $\log(1+AC)$ is larger than the estimate for $\log(1+AD)$, which implies that, at the same level of spending, DTCA is more effective than physician advertising in this market. Moreover, the estimate for $\log(1+ADOT)$ is larger than the estimate for $\log(1+AD)$, and the estimate for $\log(1+ACOT)$ is also larger than the estimate for $\log(1+AC)$. The strong spillover effects of physician advertising and DTCA are probably resulted from the small investment in advertising from branded drugs after generic entry and the increase in generic market share at the same time. The estimates for $\log(1+ADOT)$ and $\log(1+ACOT)$ capture generics' large gain from advertising by their branded rivals. In addition, the time-since-entry coefficient estimates suggest on average it takes about two months for a new drug to get attention. The first two estimates for the time-since-entry dummies are not significant at the 5% level. As a drug is on the market for more than two months, the effect of time-since-entry gets stronger and more significant.

Table 5 shows the selected estimated cost parameters. The results include the fixed effect estimates for major branded drugs and top-selling generic drugs. Also, the table presents the estimated parameters on the dummies for one month, one year and two years since entry. Other things being equal, branded atorvastatin, rosuvastatin, and lovastatin have similar marginal costs to each other while branded pravastatin has a higher marginal cost. Branded drugs' marginal costs are 2.2 to 3.6 as large as those of their generic alternatives. Moreover, comparing the estimated coefficients on the dummies for time since entry, I find that marginal cost is declining quickly since a drug's entry. This implies that drug production gets more efficient as a drug is on the market longer.

Table 6 contains price elasticities based on data for June 2006. At the end of this month, the patent of simvastatin (Zocor) expires and generic simvastatin start to enter. Table 7 summarizes the price elasticities for September 2006, three months after generic simvastatins' entry. The price elasticities for these two months help to understand the results of counterfactuals, discussed in detail later, in which Zocor aims to compete with generics using copay coupons. I discuss the results for June 2006 first. The columns are the percentage change in market share in response to one percent increase in the price of drugs in the rows. For example, the market share of ezetimibe/simvastatin (tab) is predicted to increase by 0.20% if amlodipine/atorvastatin (tab) raises price by 1%. Results for all branded drugs and the top-selling generic drugs are reported. There are several interesting findings from the table. First, all own price elasticities are larger than one in absolute value. Under the assumption of profit maximization, an own price elasticity greater than one in absolute value implies positive marginal revenue. If the own price elasticities were less than one in absolute value, then the marginal revenue and the implied marginal cost would be negative, which would make it difficult to construct a model for the counterfactual analysis. Second, own price elasticities of generic pravastatin and simvastatin are especially large. Recall that only low type consumers would choose generics and they are more price sensitive than high type consumers. Thus, a price change in generics would result in a larger change in their own market share. A mix of high and low type consumers for branded drugs leads to a lower own price elasticity.

Third, the cross price elasticities of drugs with similar characteristics are generally larger than the other cross price elasticities. For example, one percent price decrease of branded simvastatin in tablet (Zocor) has the largest impact on generic simvastatin, leading to a 3% decrease in share. Among branded drugs, those of the same form as Zocor are more affected in general. A one percent decrease in price of Zocor would lower the share of lovastatin in tablet by 1.2% while the price change only results in 0.3% decrease in the share of lovastatin in sustained-action tablet.

In addition, the substitution between branded simvastatin and generic simvastatin is quite asymmetric. The price impact of branded simvastatin on generic simvastatin is much larger than the impact of generic simvastatin on branded simvastatin. This is primarily because the market share difference between branded simvastatin and generic simvastatin is large when the generic just enter. In this month, branded simvastatin has about 5% of market share while the generic simvastatin only accounts for 0.26% of the market. The price change of branded simvastatin, therefore, has a larger impact on the percentage change of the generic's market share than the other way around.

Finally, all results in Table 7 are similar to those of Table 6, except for the elasticities with respect to the price changes of branded simvastatin. In September 2006, the market share of branded simvastatin decreases to 0.93% as generic simvastatins take over its market. The changes in the market share of generics given a price change of branded simvastatin are almost zero since most of the consumers of branded simvastatins in this month probably have a strong preference for branded drugs and they would not switch to generics. This implies that the price changes by branded simvastatin would affect the other branded drugs more than the generics when generic simvastatins are popular.

6 Counterfactual Analysis

Using the estimates for demand and supply parameters, I construct counterfactuals to explore the effects of copay coupons on social welfare. I assume that Merck, the manufacturer of branded simvastatin (Zocor), decides to issue copay coupons to consumers when its patent expires. I choose Zocor as the issuer of copay coupons for two reasons. First, I observe the entry of generic simvastatins in the data and from estimation results I learn how consumers switch to those generics from the other drugs. Second, Zocor is the best-selling branded drug before Lipitor. Understanding the outcomes of Zocor's copay coupon program would shed some light on the welfare impacts of Lipitor's coupon program. It is thus interesting to experiment with Zocor to study the welfare implications of the new pricing tactic.

There are some simplifying assumptions that facilitate the counterfactuals. The fraction of consumers receiving copay coupons is assumed to be exogenous since the manufacturer could not fully control how many consumers actually receive the coupons. Also, the insurance copay is still determined by the copayment model. Given a full price, insurers would charge consumers a share of drug costs using the estimated copay formula and they would not change the formula. Furthermore, I only consider the effects of issuing coupons during the first five months (July 2006 to Nov 2006) after Zocor's patent expires. During this period, there are three manufacturers for generic simvastatins: Teva, Ranbaxy, and Dr. Reddy's Laboratories. Teva and Ranbaxy are the first challengers of Zocor's primary U.S. patent and were granted 180-day exclusivity by FDA to sell generic simvastatins. Dr. Reddy's Laboratories received a license from Zocor to sell authorized generic simvastatins.[24] No other firms are allowed to enter the market of simvastatins during these five months.[25] There are two main reasons to restrict the experiment to the 180-day exclusivity period. First, with limited generic competition, branded drug manufacturers have more incentive to use copay coupons than when generic competition is severe. Once there are many generics in the market, generic prices are usually very low and the coupons would not be as attractive to consumers. Second, the lack of a model for entry makes it difficult to tackle the possible generic entrants after the exclusivity period.

Suppose there are J_t drugs in period t and the fraction of consumers receiving a copay

[24] According the FTC report on authorized generics, outside licensees' pricing decisions are typically independent of the branded drug manufacturers. Thus, I treat Dr. Reddy's Laboratories as a competitor to Merck rather than a partner.

[25] In late December 2006, other generics started to enter the market and thus I exclude this month in the policy simulation.

coupon from Zocor is $q \in (0,1)$, firms compete in a Bertrand game and maximize their own profits, under the full information assumption, by simultaneously choosing their full prices $(p_1, p_2, ..., p_{J_t})$ and, for Zocor, the copay with a coupon $(\tilde{p}^c_Z)$.[26] Insurers decide the insurance copay for each drug $(p^c_1, p^c_2, ..., p^c_{J_t})$ using the copay formula. Consumers with a copay coupon face copays $[p^c_1, p^c_2, ..., \min\{p^c_Z, \tilde{p}^c_Z\}, ..., p^c_{J_t}]$ and consumers without a copay coupon face copays $[p^c_1, p^c_2, ..., p^c_Z, ..., p^c_{J_t}]$. Note that a consumer with a copay coupon from Zocor will compare the copay using the coupon with the insurance copay. If the copay from coupon is higher than the insurance copay for Zocor, the consumer will not use the coupon at all.

With the equilibrium prices, I can calculate the change in firm profits, consumer welfare and insurer's spending. The profit from Zocor in period t with copay coupons is

$$\pi_Z = M_t \left[(1-q)\left(p_{Zt} - mc_{Zt}\right) s^{NC}_{Zt} + q\left(p_{Zt} - p^c_{Zt} + \min\{\tilde{p}^c_{Zt}, p^c_{Zt}\} - mc_{Zt}\right) s^C_{Zt} \right] \\ - AD_{Zt} - AC_{Zt},$$

where s^{NC}_{Zt} is Zocor's share from those without a coupon and s^C_{Zt} the share from those with a coupon. The revenue from those with a coupon is insurer's payment $(p_{Zt} - p^c_{Zt})$ plus the minimum of copay using a coupon and insurance copay $(\min\{\tilde{p}^c_{Zt}, p^c_{Zt}\})$. Under the GEV error structure, the expected consumer surplus in period t, measured in dollars, before copay coupons are used can be expressed as

$$E\left(CS_{0t}\right) = M_t \left[\lambda \left(\frac{1}{-\alpha^H}\right) \log(G^H_t) + (1-\lambda)\left(\frac{1}{-\alpha^L}\right) \log(G^L_t) + C_E \right], \tag{15}$$

where C_E is the Euler's constant. The expected consumer surplus in period t, measured in

[26] In this case, choosing the copay for coupon users $(\tilde{p}^c_Z)$ is equivalent to choosing the coupon value $(p^c_Z - \tilde{p}^c_Z)$ since, given p_Z, p^c_Z is decided according to the copay formula and the formula is fixed throughout the game.

dollars, after copay coupons are used is

$$E\left(CS_{1t}\right) = M_t \Big[\lambda \left(\frac{1}{-\alpha^H}\right) \Big(q \log(G_t^{H,C}) + (1-q)\log(G_t^{H,NC}) \Big) + \\ (1-\lambda)\left(\frac{1}{-\alpha^L}\right) \Big(q \log(G_t^{L,C}) + (1-q)\log(G^{L,NC})_t \Big) + C_E \Big], \quad (16)$$

where $G_t^{H,C}$ and $G_t^{H,NC}$ are the G function values from high type consumers with and without a copay coupon, respectively. $G_t^{L,C}$ and $G_t^{L,NC}$ are the G function values from low type consumers with and without a copay coupon, respectively. The change in the expected consumer surplus in period t is

$$\Delta E(CS_t) = E\left(CS_{1t}\right) - E\left(CS_{0t}\right). \quad (17)$$

The Euler's constants in $E\left(CS_{1t}\right)$ and $E\left(CS_{0t}\right)$ simply cancel out.

An additional assumption needs to be made to solve for equilibrium prices. Theoretically, Zocor would set $p_Z = \infty$ and $\tilde{p}_Z^c \approx 0$ for any $q > 0$. This way, Zocor can concentrate on the consumers with copay coupons and receive an infinite payment from the insurance companies for each of these consumers. Figure 6 illustrates how Merck's profit changes with Zocor's full price when $q = 0.05$, holding fixed the other prices and the copay with coupon. The profit from those who do not have a coupon reaches a maximum at the price of 2.4 while the profit from coupon users is strictly increasing in the full price of Zocor. Merck's total profit is always increasing in the full price of Zocor since the profit increase from coupon users is larger than the profit decrease from coupon nonusers beyond the price of 2.4. To limit the equilibrium prices to a reasonable level, I set an upper bound for Zocor's price equal to 1.25 times the current Zocor's price. Beyond that point, I assume that the insurer will remove the drug from its prescription drug list. The choice of the upper bound is based on the fact that Lipitor's real price increased by about 23.8% over the two years since its coupon program was introduced in late 2010.[27] The price increase by Lipior has led some insurers

[27] "Rx Price Watch Case Study: Efforts to Reduce the Impact of Generic Competition for Lipitor," American Association of Retired Persons, June 2013.

and pharmacy benefit managers to exclude Lipitor from their prescription drug lists.[28]

I consider two counterfactuals: (1) consumers who receive copay coupons and those who do not are equally price sensitive, and (2) consumers who receive copay coupons are all low type (on average, they are more price sensitive than those who do not receive coupons). In counterfactual 1, Merck cannot price discriminate based on price sensitivities since the composition of coupon users and nonusers is the same. Thus, the results from counterfactual 1 are all driven by the agency problem between insurers and patients. In counterfactual 2, I allow Merck to target coupons to the most price-sensitive individuals to understand how coupon targeting and the agency issue together change the effects of coupons on welfare.

Within the two counterfactuals, I consider a case with no price response and a case with price response. In the case with no price response, Merck sets the copay for coupon users to maximize its profit, holding all prices (including Zocor's price) fixed. In the other case, firms are allowed to respond by choosing prices to re-optimize profits. Comparing the results from the two cases could show how strategic interaction affects social welfare when copay coupons are introduced. In addition, I solve for equilibrium prices in each counterfactual for different degrees of coupon penetration to learn how expanding the coupon program affects welfare and profits.

6.1 Counterfactual 1: Baseline

Table 8 shows that Merck sets the copay for coupon users equal to less than half the insurance copay for Zocor when all full prices are fixed. The copay with coupons is also lower than the average insurance copay for generic simvastatins and close to the average insurance copay for the other generics. This results in an increase in Zocor's market share by more than three times when there are only 5% of consumers receiving copay coupons. As the fraction of consumers with a coupon increases to 50%, Zocor's market share becomes 37 times as large as its original level. The other drugs' combined market share drops by about 10 percentage points (40%). These show that Merck wants to aggressively lower the copay

[28]For example, starting on January 1, 2013, UnitedHealthcare stops offering Lipitor to its plan enrollees because of Lipitor's high price and extensive use of copay coupons.

for coupon users to expand Zocor's market share.

The low copay set by Merck has a large impact on firm profits and insurance payments. Table 9 shows that consumers benefit from copay coupons because some of them could buy Zocor at a low price and those without coupons face the same price as before. Change in consumer welfare is 3.27% when 5% of consumers receive coupons and 6.53% when coupon penetration rate is 10%. On the other hand, Merck's profit from Zocor increases by 12 million dollars when only 5% of consumers receive coupons. The small fraction of consumers who get a coupon more than doubles Merck's profits from Zocor. At the same time, insurance spending largely grows by 15% or 129 million dollars since most consumers who receive a coupon choose branded Zocor and it is more expensive than the other drugs in the market. The net effect of the coupon program is negative mainly because of the large increase in insurance payment. The net effects of copay coupons on social welfare get more negative as the coupon program expands.

When firms are allowed to change prices in response to introduction of coupons, Merck would set a very low copay for coupon users and raise the full price of Zocor as high as possible. This way, Merck is able to attract most of the consumers with a coupon and earn a large profit from the insurer. Table 10 shows that all full prices of Zocor hit the upper bound (1.25 times the original price) and the copay for coupon users is lower than any insurance copay in the market. The pricing strategy implies that Merck views the market with coupons as its main source of profits. The low copays for coupon users make Zocor's market shares larger at any level of coupon penetration than its corresponding market shares under no price response.

It is interesting to note the average equilibrium prices of the other branded drugs manufactured by Merck get higher and higher as the coupon program expands. When more people receive the coupon, Merck would want to make the coupon more attractive by raising the prices of its other branded products. Doing so would sacrifice some market share from those without a coupon but bring Merck more profits since the profit margin of Zocor are much larger than that of Merck's other branded drugs. On the other hand, the average price of branded products from the other drug manufacturers jumps from 70.97 to 72.43 when coupon penetration rate moves from 0% to 5%. Then the average price slightly drops to 72.30 as 50% of the consumers receive a coupon. There are two forces behind this price pattern. First, when coupon is introduced, Merck sets a higher price for Zocor, which mitigates price competition in the market and drives up the average price of non-Merck branded drugs. Second, for those who receive a coupon, the coupon program intensifies price competition because of the low coupon copay. This puts downward pressure on the average price of the other branded products. When only a few consumers receive a coupon, the first force dominates and thus the average price of non-Merck branded drugs becomes higher. As the coupon penetration increases, firms care more and more about the market of coupon users and the second force gets stronger. Therefore, the average price of non-Merck branded drugs starts to drop.

Table 11 shows that the coupon program increases consumer welfare, Zocor's profit, and insurer spending more than it does in the no-response case. The increase in consumer welfare is only 3.53% when coupon penetration rate is 5%, a number similar to the increase in consumer welfare in the no-response case. The lower copay for coupon users benefits consumers but the mitigated price competition hurt consumers. Therefore, the net effect of coupons on consumer welfare is not obvious when only 5% of consumers receive a coupon. The increase in consumer welfare is more significant as coupon penetration gets larger when the other firms cut prices for their branded products to compete for those who have a coupon. The consumer welfare gain when 50% of consumers receive a coupon is about 59.8%, compared to 32.7% in the no-response case.

Compared to the no-response case, Merck further improves its profits from Zocor by issuing coupons since they are now allowed to raise full prices. The gains of Merck and consumers come at the cost of insurance payments. The increase in insurer spending in the price-response case is 70% more than the increase in the no-response case. Insurance payments increase by 25% when 5% of consumers get a coupon and by about 50% when the coupon penetration rate is 10%. In addition, when 5% of consumers receive coupons, the other branded drugs have a higher combined profit than before coupons are introduced because price competition is alleviated. As coupons become more popular, change in the profits of the other branded drugs turns negative but the negative effects of coupons on the other branded drugs' profits are weaker than in the no-response case since firms can adjust prices to compete for those with a coupon.

The results from counterfactual 1 show that coupons benefit the issuer by taking advantage of the agency problem between insurers and patients. Copay coupons can help the issuer to induce consumers to buy its product by reducing their copays and raising the full price. This way, the issuer of coupons can earn a large profit from insurance companies. In most cases, the other firms are hurt by the coupon program since it is difficult to compete for consumers who have a coupon. Insurance companies lose a lot after coupons are introduced as consumers have a strong incentive to choose the expensive product with a low copay from coupons.

6.2 Counterfactual 2: Coupon Targeting

In counterfactual 2, I assume Merck has the ability to direct coupons to the most price-sensitive types of consumers. Thus, all consumers who receive a coupon are assumed to be low type. Most of the results from counterfactual 2 are consistent with those of counterfactual 1. Thus, I focus on the major differences between the results in the counterfactuals and discuss how the ability to target coupons contributes to the differences.

First, in the no-response case of counterfactual 2, the copay for coupon users is slightly lower than in the no-response case of counterfactual 1. Table 12 shows that the copay is set to be $7.45, compared with $7.57 in counterfactual 1. Because now the coupon users are more price sensitive, the optimal copay for them becomes lower. Second, we learn from Table 13 that the increase in Merck's profits from Zocor is larger than in counterfactual 1 and the decrease in the other branded drugs' profits is much smaller. In contrast, the loss in generics' profits becomes larger. In counterfactual 2, there are more high type consumers among those without a coupon, for a given coupon penetration rate, than in counterfactual

1. Since they only consider branded drugs, branded drugs' market shares and profits are less affected by coupons than in counterfactual 1. Also, generics are hurt more in counterfactual 2 because of a higher proportion of high-type consumers without a coupon who do not choose generics at all.

Third, Table 14 shows that Zocor's prices hit the upper bound again in the price-response case. The equilibrium copay for coupon users is slightly lower than the copay value in the price-response case in counterfactual 1 since in counterfactual 2 the coupon users are more price sensitive. Also, the other branded drugs' average optimal prices are higher than those in the price-response case of counterfactual 1. Since the other branded drug manufacturers know that those without a coupon are on average less price sensitive than those with a coupon, it is optimal for them to charge a higher full price to capture the consumers without coupons. However, the average optimal prices of the non-Merck branded drugs do not drop as in counterfactual 1. The average non-Merck prices get higher as more and more low-type consumers have a coupon. In addition to the two forces that drive the non-Merck firms' pricing discussed in counterfactual 1, Merck's ability to target coupons to more price-sensitive consumers makes the other branded drug manufacturers care more about the consumers without coupons by raising full prices to exploit their lower price sensitivity. This "third force" further mitigates price competition in the market.

The mitigated price competition leads to a positive profit change for non-Merck branded manufacturers after coupons are introduced. Table 15 shows that changes in the profits of the other branded drugs are all positive and the positive changes gets larger as more low-type consumers have a coupon. The profits from Zocor are also larger than in counterfactual 1 because the difference between Zocor's price and the price of the other branded drugs narrows, which leads to a larger market share of Zocor in the consumers without coupons. Finally, consumer welfare gains are smaller compared to the gains in the price-response case in counterfactual 1. In counterfactual 2, consumers face higher average prices, which dominates the effect of lower copay for coupon users and leads to a smaller consumer welfare gain.

To sum up, Zocor's coupon targeting helps screen consumers and lowers the average price sensitivity of those without a coupon. This further mitigates price competition among branded drugs and benefits not only Merck but the other branded drug manufacturers as well.

7 Conclusion

To understand the impacts of copay coupons on consumers, drug manufacturers, and insurance companies, I estimate a model with consumer heterogeneity and rich substitution patterns and demonstrate the effects of copay coupons on the healthcare system in the counterfactuals. I consider two motivations to use copay coupons: the agency problem and coupon targeting. First, I find that the agency problem between insurers and patients can make copay coupons highly profitable. Copay coupons benefit the coupon issuer and consumers at the cost of larger insurance payments. The other firms are hurt in most cases since they could hardly compete for the consumers with a coupon. Second, when I allow for coupon targeting, the coupon benefits for the coupon issuer become larger because targeting enables coupons to screen consumers and mitigate price competition among branded drugs. In this case, most of the branded drug manufacturers also benefit from the introduction of copay coupons.

There are several interesting extensions for the study of copay coupons in pharmaceuticals. First, copay coupons can be used for competition between branded drugs. In the paper, I only consider the case with a single coupon issuer after its patent expires. Competition using coupons when there are no generics available can expand the overall market and have different welfare implications. Second, solving for advertising spending with the introduction of coupons can improve the welfare analysis. Usually, branded drugs cut advertising spending after generics enter because of generics' free-riding problem. With copay coupons, branded drug manufacturers may have a stronger incentive to advertise since they would want to attract more coupon users. If advertising is valuable to consumers, the gain in consumer welfare from coupons could be larger with more advertising.

Finally, in addition to the agency problem and price discrimination, dynamics could motivate branded drug manufacturers to use copay coupons. For example, they may use coupons to build brand loyalty and help patients stay on their medicines after they stop offering coupons. Also, copay coupons could be used to deter generic entry since the low copay with coupons makes it very difficult for generics to compete with branded drugs. Incorporating these dynamic motivations would complement the static analysis in the paper and provide more insights on the welfare implications of copay coupons.

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Table 1: Statins and Statin Combinations

Class	Molecule	Brand Name	Form	Brand Entry	1st Generic Entry	Max Num Generics
Statins	atorvastatin	Lipitor	TAB	Jan 1997	-	-
	fluvastatin	Lescol	CAP	Apr 1994	-	-
	fluvastatin	Lescol XL	SA TAB	Nov 2000	-	-
	lovastatin	Altoprev	SA TAB	Jul 2002	-	-
	lovastatin	Mevacor	TAB	Sep 1987	Feb 2002	11
	pravastatin	Pravachol	TAB	Nov 1991	May 2006	14
	rosuvastatin	Crestor	TAB	Aug 2003	-	
	simvastatin	Zocor	TAB	Jan 1992	Jun 2006	16
Statin Combinations	amlodipine/atorvastatin	Caduet	TAB	Mar 2004	-	-
	ezetimibe/simvastatin	Vytorin	TAB	Jul 2004	-	-
	lovastatin/niacin	Advicor	SA TAB	Dec 2001	-	-
	niacin/simvastatin	Simcor	SA TAB	Feb 2008	-	-

Table 2: Price, Market Share, and Advertising Spending

Variable	Obs	Mean	Std. Dev.	Min	Max
Full sample					
Price	3638	1.0642	1.0127	0.0378	5.0874
Share	3638	0.0082	0.0169	0.0000	0.0948
Physician ad	3638	1,544,225	4,112,393	0	30,083,698
DTCA	3638	709,144	2,894,856	0	31,339,548
Branded without generic equivalent					
Price	812	2.3090	0.7267	0.9864	5.0874
Share	812	0.0198	0.0267	0.0000	0.0948
Physician ad	812	6,741,131	6,380,512	0	30,083,698
DTCA	812	3,176,964	5,452,706	0	31,339,548
Branded with generic equivalent					
Price	335	2.2223	0.8930	0.6456	4.3290
Share	335	0.0010	0.0031	0.0000	0.0499
Physician ad	335	415,167	791,388	0	3,602,323
DTCA	335	510	3,001	0	31,741
Generics					
Price	2491	0.5027	0.4668	0.0378	4.5666
Share	2491	0.0053	0.0113	0.0000	0.0790
Physician ad	2491	2,012	11,220	0	99,532
DTCA	2491	0	0	0	0

Note: Observation is at the month-molecule-branded-form-firm level.

Table 3: Copay Estimates

	γ_0		γ_1			
Year	Est	S.E.	Est	S.E.	Plans	Total Rx
2003	−1.2393	0.0062	0.8290	0.0101	68	216920
2004	−1.2981	0.0047	0.8901	0.0086	64	129140
2005	−1.2407	0.0082	0.9064	0.0090	230	92820
2006	−1.4343	0.0141	0.9469	0.0146	295	155230
2007	−1.2624	0.0076	0.8469	0.0062	205	1431612
2008	−1.3486	0.0118	0.8682	0.0056	104	739917
2009	−1.3315	0.0182	0.8448	0.0058	204	165248

Note: Parameters are weighted OLS estimates with clustered standard errors by enrollee. Sample includes only prescriptions with 30-day supply and insurance plans with more than 10 thousand enrollees.

Table 4: Demand Parameters

	Est	S.E.
Nonlinear parameters:		
Nesting Parameters		
Class	0.6544	0.1995
Branded/generic	0.6323	0.2038
Molecule	0.5597	0.1255
Form	0.6650	0.0884
Proportion of high type (λ)	0.1426	0.0072
α^H	-8.6783	1.5405
α^L	-27.2243	0.9199
Linear parameters (selected):		
β^{AD}	0.1352	0.0478
β^{AC}	0.6078	0.0395
β^{ADOT}	0.3101	0.0530
β^{ACOT}	0.8623	0.2269
1m since entry	1.7625	2.2204
2m since entry	2.6343	1.9586
3m since entry	4.5392	2.2644
4m since entry	3.7120	1.9795
5m since entry	3.7589	1.9378
6m since entry	2.9701	1.7709

Note: N = 3638. Parameters are GMM estimates with heteroskedasticity-robust standard errors.

Table 5: Selected Cost Parameters

	Est.	S.E.
Atorvastatin (branded)	1.5261	0.1237
Rosuvastatin (branded)	1.4986	0.1243
Simvastatin (branded)	1.8890	0.1237
Simvastatin (generic)	0.2456	0.1352
Lovastatin (branded)	1.4960	0.1237
Lovastatin (generic)	0.2272	0.1457
Pravastatin (branded)	3.1775	0.1237
Pravastatin (generic)	0.5710	0.1347
One month since entry	1.3846	0.2588
One year since entry	0.3548	0.1546
Two years since entry	0.1745	0.1375

Note: N = 3638. The unit is dollar per patient-day. Adjusted R-squared = 0.71. Parameters are GMM estimates with homoskedasticity-only standard errors.

Table 6: Price Elasticities for June 2006

			Branded											Generic		
	Molecule (form)	Share	amlodipine/atorvastatin (tab)	ezetimibe/simvastatin (tab)	lovastatin/niacin (sa tab)	atorvastatin (tab)	fluvastatin (cap)	fluvastatin (sa tab)	lovastatin (tab)	lovastatin (sa tab)	pravastatin (tab)	rosuvastatin (tab)	simvastatin (tab)	lovastatin (tab)	pravastatin (tab)	simvastatin (tab)
Branded	amlodipine/atorvastatin (tab)	0.28%	−6.97	0.03	0.35	0.11	0.09	0.00	0.08	0.00	0.12	0.05	0.11	0.00	0.00	0.00
	ezetimibe/simvastatin (tab)	3.41%	0.20	−9.75	0.26	0.21	0.13	0.68	0.49	0.81	0.05	0.67	0.16	0.62	0.56	0.59
	lovastatin/niacin (sa tab)	0.18%	0.17	0.02	−6.97	0.04	0.04	0.06	0.03	0.08	0.05	0.02	0.04	0.01	0.01	0.01
	atorvastatin (tab)	9.48%	2.81	0.93	2.23	−5.08	2.26	0.65	2.29	0.84	3.14	1.92	3.27	0.74	0.63	0.69
	fluvastatin (cap)	0.11%	0.03	0.01	0.02	0.02	−6.90	0.07	0.02	0.01	0.03	0.01	0.03	0.01	0.00	0.00
	fluvastatin (sa tab)	0.55%	0.00	0.08	0.09	0.02	0.19	−8.49	0.05	1.24	0.00	0.07	0.01	0.08	0.07	0.08
	lovastatin (tab)	0.01%	0.00	0.00	0.00	0.00	0.00	0.00	−8.83	0.02	0.00	0.00	0.00	0.00	0.00	0.00
	lovastatin (sa tab)	0.15%	0.00	0.03	0.04	0.01	0.00	0.35	0.29	−10.77	0.00	0.02	0.00	0.08	0.02	0.03
	pravastatin (tab)	0.41%	0.15	0.01	0.12	0.15	0.12	0.00	0.10	0.01	−6.31	0.07	0.16	0.00	0.03	0.00
	rosuvastatin (tab)	1.82%	0.21	0.47	0.21	0.31	0.22	0.38	0.41	0.48	0.24	−11.00	0.29	0.44	0.38	0.41
	simvastatin (tab)	4.99%	1.58	0.37	1.25	1.76	1.26	0.25	1.20	0.32	1.75	0.95	−6.24	0.28	0.24	2.93
Generic	lovastatin (tab)	0.80%	0.00	0.05	0.01	0.01	0.01	0.06	0.08	0.20	0.00	0.05	0.01	−5.11	0.17	0.18
	pravastatin (tab)	0.39%	0.00	0.13	0.02	0.03	0.02	0.14	0.10	0.16	0.04	0.13	0.02	0.46	−27.90	0.41
	simvastatin (tab)	0.26%	0.00	0.06	0.01	0.02	0.01	0.06	0.05	0.07	0.00	0.06	0.13	0.22	0.18	−19.68

Note: Cell entries (i, j), where i indexes row and j column, give the percent change in market share of brand j with a one-percent change in price of i.

Table 7: Price Elasticities for Sep 2006

	Molecule (form)	Share	Branded: amlodipine/atorvastatin (tab)	ezetimibe/simvastatin (tab)	lovastatin/niacin (sa tab)	atorvastatin (tab)	fluvastatin (cap)	fluvastatin (sa tab)	lovastatin (tab)	lovastatin (sa tab)	pravastatin (tab)	rosuvastatin (tab)	simvastatin (tab)	Generic: lovastatin (tab)	pravastatin (tab)	simvastatin (tab)
Branded	amlodipine/atorvastatin (tab)	0.30%	−7.05	0.11	0.16	0.14	0.12	0.02	0.12	0.04	0.13	0.13	0.13	0.00	0.00	0.00
	ezetimibe/simvastatin (tab)	3.49%	0.66	−6.55	0.52	0.41	0.35	0.82	0.41	0.95	0.38	0.42	0.39	0.29	0.27	0.30
	lovastatin/niacin (sa tab)	0.17%	0.07	0.04	−5.21	0.05	0.05	0.08	0.05	0.14	0.05	0.05	0.05	0.00	0.00	0.00
	atorvastatin (tab)	8.85%	3.16	1.63	2.87	−2.33	2.96	0.47	3.12	1.02	3.46	3.57	3.67	0.02	0.02	0.02
	fluvastatin (cap)	0.09%	0.03	0.01	0.03	0.03	−5.41	0.14	0.03	0.01	0.03	0.03	0.03	0.00	0.00	0.00
	fluvastatin (sa tab)	0.47%	0.01	0.09	0.11	0.01	0.39	−7.71	0.02	1.01	0.01	0.02	0.01	0.05	0.04	0.05
	lovastatin (tab)	0.01%	0.00	0.00	0.00	0.00	0.00	0.00	−6.19	0.10	0.00	0.00	0.00	0.00	0.00	0.00
	lovastatin (sa tab)	0.13%	0.01	0.03	0.06	0.01	0.01	0.29	1.23	−8.57	0.01	0.01	0.01	0.04	0.01	0.01
	pravastatin (tab)	0.31%	0.11	0.06	0.11	0.13	0.11	0.02	0.11	0.04	−5.58	0.12	0.12	0.00	0.00	0.00
	rosuvastatin (tab)	1.90%	0.54	0.31	0.49	0.65	0.51	0.12	0.53	0.22	0.58	−5.04	0.60	0.03	0.03	0.03
	simvastatin (tab)	0.93%	0.34	0.17	0.31	0.40	0.32	0.05	0.33	0.11	0.36	0.36	−5.60	0.00	0.00	0.00
Generic	lovastatin (tab)	0.81%	0.00	0.03	0.00	0.00	0.00	0.04	0.01	0.12	0.00	0.00	0.00	−5.83	0.12	0.15
	pravastatin (tab)	0.40%	0.00	0.07	0.00	0.00	0.00	0.10	0.01	0.09	0.00	0.01	0.00	0.30	−27.49	0.31
	simvastatin (tab)	2.79%	0.00	0.32	0.01	0.01	0.01	0.49	0.04	0.45	0.00	0.04	0.00	1.70	1.37	−16.48

Note: Cell entries (i, j), where i indexes row and j column, give the percent change in market share of brand j with a one-percent change in price of i.

Table 8: Simulated Price, Copay, and Market Share (Counterfactual 1, No Response)

	Fraction of consumers with copay coupons				
	0%	5%	10%	30%	50%
Average price for one month supply					
Branded simvastatin	76.81	76.81	76.81	76.81	76.81
Generic simvastatin	54.43	54.43	54.43	54.43	54.42
Other branded by Merck	46.00	46.00	46.00	46.00	46.00
Other branded by non-Merck	70.97	70.98	70.98	71.00	71.02
Other generic	31.85	31.86	31.88	31.97	32.11
Average copay for one month supply					
Copay from coupon		7.57	7.57	7.57	7.57
Branded simvastatin	17.40	17.40	17.40	17.40	17.40
Generic simvastatin	12.54	12.54	12.54	12.54	12.53
Other branded by Merck	10.71	10.71	10.71	10.71	10.71
Other branded by non-Merck	16.14	16.14	16.14	16.15	16.15
Other generic	7.41	7.42	7.42	7.44	7.47
Market share					
Branded simvastatin	0.0103	0.0467	0.0830	0.2285	0.3740
Generic simvastatin	0.0519	0.0496	0.0472	0.0378	0.0285
Other branded by Merck	0.0351	0.0338	0.0325	0.0272	0.0219
Other branded by non-Merck	0.1232	0.1187	0.1141	0.0957	0.0774
Other generic	0.0374	0.0359	0.0344	0.0283	0.0222

Table 9: Change in Welfare, Profits, and Spending (Counterfactual 1, No Response)

		Fraction of consumers with copay coupons			
	Original level	5%	10%	30%	50%
Consumer welfare	194,662,531.8	6,356,325.1	12,712,650.2	38,137,950.6	63,563,251.0
Profits: branded simvastatin	11,201,575.4	12,357,245.4	24,714,490.8	74,143,472.4	123,572,453.9
Profits: generic simvastatin	14,316,579.5	-646,220.9	-1,292,441.7	-3,877,325.1	-6,462,208.5
Profits: other branded by Merck	18,393,541.7	-695,074.9	-1,390,149.8	-4,170,449.3	-6,950,748.8
Profits: other branded by non-Merck	254,523,547.0	-9,499,596.4	-18,999,192.8	-56,997,578.3	-94,995,963.9
Profits: other generic	9,289,489.2	-376,038.8	-752,077.5	-2,256,232.5	-3,760,387.6
Insuerer spending	875,612,978.9	129,256,872.8	258,513,745.6	775,541,236.8	1,292,568,728.0

Table 10: Simulated Price, Copay, and Market Share (Counterfactual 1, Price Response)

	Fraction of consumers with copay coupons				
	0%	5%	10%	30%	50%
Average price for one month supply					
Branded simvastatin	76.81	96.01	96.01	96.01	96.01
Generic simvastatin	54.43	54.43	54.43	54.42	54.42
Other branded by Merck	46.00	46.84	47.36	50.58	59.98
Other branded by non-Merck	70.97	72.43	72.41	72.27	72.30
Other generic	31.85	31.82	31.83	31.84	31.88
Average copay for one month supply					
Copay from coupon		5.76	5.76	5.76	5.76
Branded simvastatin	17.40	21.50	21.50	21.50	21.50
Generic simvastatin	12.54	12.54	12.54	12.54	12.53
Other branded by Merck	10.71	10.90	11.01	11.72	13.77
Other branded by non-Merck	16.14	16.46	16.45	16.42	16.43
Other generic	7.41	7.41	7.41	7.41	7.42
Market share					
Branded simvastatin	0.0103	0.0490	0.0952	0.2800	0.4653
Generic simvastatin	0.0519	0.0496	0.0472	0.0373	0.0272
Other branded by Merck	0.0351	0.0321	0.0285	0.0152	0.0045
Other branded by non-Merck	0.1232	0.1228	0.1178	0.0980	0.0782
Other generic	0.0374	0.0358	0.0341	0.0272	0.0201

Table 11: Change in Welfare, Profits, and Spending (Counterfactual 1, Price Response)

		Fraction of consumers with copay coupons			
	Original level	5%	10%	30%	50%
Consumer welfare	194,662,531.8	6,864,589.0	19,008,684.4	67,697,550.9	116,383,406.9
Profits: branded simvastatin	11,201,575.4	58,046,660.7	119,968,652.5	367,862,924.0	616,441,887.7
Profits: generic simvastatin	14,316,579.5	-613,383.0	-1,282,357.7	-3,996,725.1	-6,797,600.0
Profits: other branded by Merck	18,393,541.7	423,045.9	-592,300.0	-5,279,696.4	-11,353,305.4
Profits: other branded by non-Merck	254,523,547.0	10,024,435.3	-953,866.3	-44,690,867.6	-87,381,505.4
Profits: other generic	9,289,489.2	-387,711.2	-810,921.8	-2,528,383.7	-4,300,682.8
Insurer spending	875,612,978.9	220,003,791.5	436,672,600.6	1,306,256,969.7	2,183,667,082.5

Table 12: Simulated Price, Copay, and Market Share (Counterfactual 2, No Response)

	Fraction of consumers with copay coupons				
	0%	5%	10%	30%	50%
Average price for one month supply					
Branded simvastatin	76.81	76.81	76.81	76.81	76.81
Generic simvastatin	54.43	54.43	54.43	54.43	54.41
Other branded by Merck	46.00	46.00	46.00	46.01	46.01
Other branded by non-Merck	70.97	71.05	71.12	71.41	71.71
Other generic	31.85	31.86	31.88	31.99	32.18
Average copay for one month supply					
Copay from coupon		7.45	7.45	7.45	7.45
Branded simvastatin	17.40	17.40	17.40	17.40	17.40
Generic simvastatin	12.54	12.54	12.54	12.54	12.53
Other branded by Merck	10.71	10.71	10.71	10.71	10.71
Other branded by non-Merck	16.14	16.16	16.17	16.24	16.30
Other generic	7.41	7.42	7.42	7.44	7.49
Market share					
Branded simvastatin	0.0103	0.0481	0.0858	0.2369	0.3880
Generic simvastatin	0.0519	0.0491	0.0464	0.0353	0.0243
Other branded by Merck	0.0351	0.0342	0.0333	0.0295	0.0257
Other branded by non-Merck	0.1232	0.1229	0.1225	0.1211	0.1197
Other generic	0.0374	0.0356	0.0338	0.0266	0.0194

Table 13: Change in Welfare, Profits, and Spending (Counterfactual 2, No Response)

		Fraction of consumers with copay coupons			
	Original level	5%	10%	30%	50%
Consumer welfare	194,662,531.8	5,535,041.2	11,070,082.5	33,210,247.4	55,350,412.3
Profits: branded simvastatin	11,201,575.4	12,895,452.4	25,790,904.8	77,372,714.5	128,954,524.2
Profits: generic simvastatin	14,316,579.5	-761,177.6	-1,522,355.2	-4,567,065.6	-7,611,776.1
Profits: other branded by Merck	18,393,541.7	-491,852.6	-983,705.2	-2,951,115.7	-4,918,526.1
Profits: other branded by non-Merck	254,523,547.0	-257,056.3	-514,112.6	-1,542,337.7	-2,570,562.8
Profits: other generic	9,289,489.2	-447,007.0	-894,014.0	-2,682,042.0	-4,470,070.0
Insurer spending	875,612,978.9	152,541,837.8	305,083,675.5	915,251,026.5	1,525,418,377.5

Table 14: Simulated Price, Copay, and Market Share (Counterfactual 2, Price Response)

	Fraction of consumers with copay coupons				
	0%	5%	10%	30%	50%
Average price for one month supply					
Branded simvastatin	76.81	96.01	96.01	96.01	96.01
Generic simvastatin	54.43	54.43	54.43	54.42	54.42
Other branded by Merck	46.00	46.88	47.40	49.98	53.11
Other branded by non-Merck	70.97	72.70	72.94	73.98	75.08
Other generic	31.85	31.82	31.82	31.84	31.88
Average copay for one month supply					
Copay from coupon		5.72	5.72	5.72	5.72
Branded simvastatin	17.40	21.50	21.50	21.50	21.50
Generic simvastatin	12.54	12.54	12.54	12.54	12.54
Other branded by Merck	10.71	10.91	11.02	11.59	12.27
Other branded by non-Merck	16.14	16.51	16.56	16.79	17.03
Other generic	7.41	7.41	7.41	7.41	7.42
Market share					
Branded simvastatin	0.0103	0.0499	0.0968	0.2847	0.4727
Generic simvastatin	0.0519	0.0492	0.0464	0.0347	0.0228
Other branded by Merck	0.0351	0.0328	0.0299	0.0206	0.0146
Other branded by non-Merck	0.1232	0.1277	0.1276	0.1277	0.1279
Other generic	0.0374	0.0356	0.0336	0.0254	0.0170

Table 15: Change in Welfare, Profits, and Spending (Counterfactual 2, Price Response)

		Fraction of consumers with copay coupons			
	Original level	5%	10%	30%	50%
Consumer welfare	194,662,531.8	5,283,263.7	15,838,833.2	58,087,913.8	100,554,876.2
Profits: branded simvastatin	11,201,575.4	59,167,107.4	122,220,131.4	374,608,343.3	627,134,758.6
Profits: generic simvastatin	14,316,579.5	-726,233.7	-1,512,062.5	-4,719,585.5	-8,021,825.8
Profits: other branded by Merck	18,393,541.7	891,624.5	393,029.5	-1,523,858.7	-3,006,047.2
Profits: other branded by non-Merck	254,523,547.0	22,670,858.5	24,431,751.6	32,519,996.4	41,332,688.5
Profits: other generic	9,289,489.2	-459,353.4	-956,731.0	-2,987,274.9	-5,078,442.5
Insurer spending	875,612,978.9	246,934,091.7	490,937,637.2	1,472,886,081.7	2,463,118,753.7

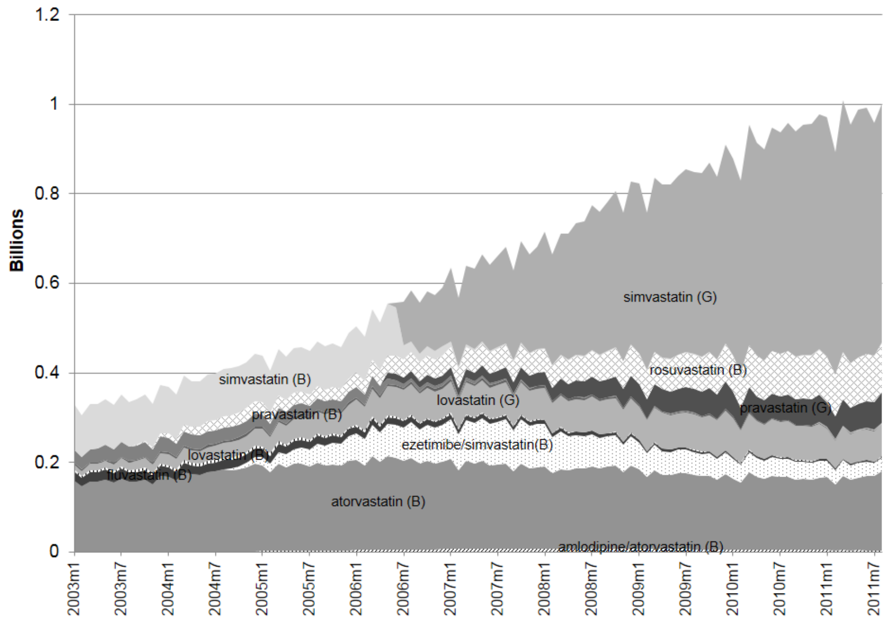

Figure 1: Sales (Patient-Days)

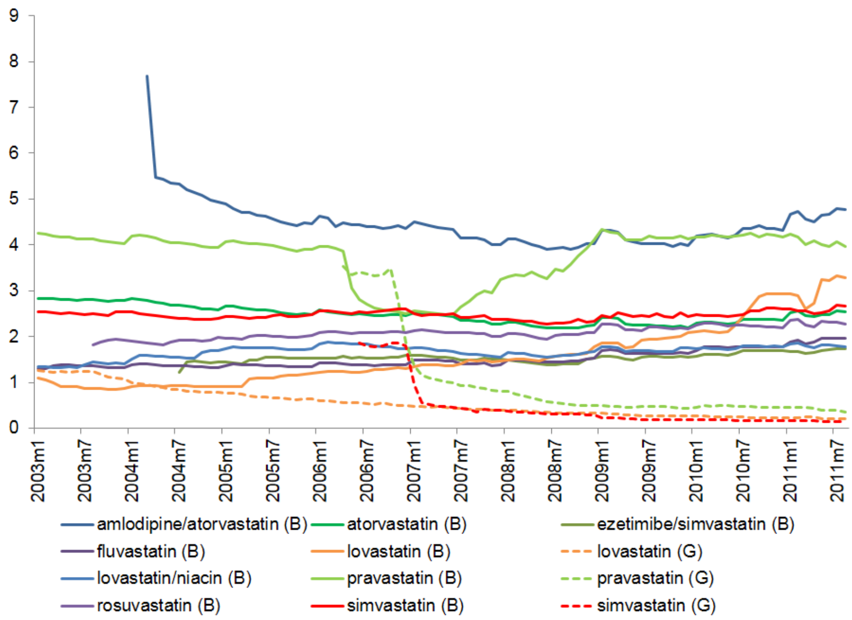

Figure 2: Price per Patient-Day

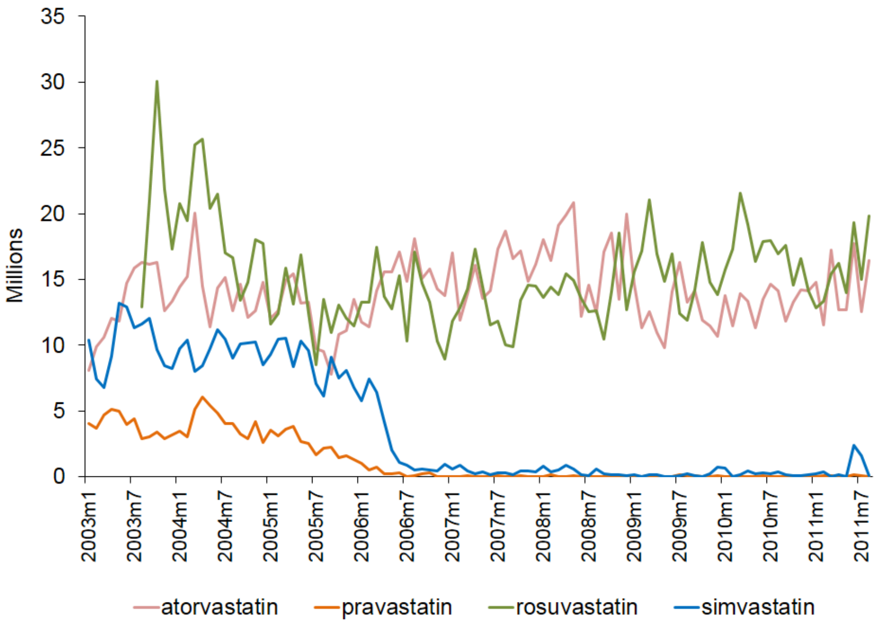

Figure 3: Spending on Advertising to Physicians

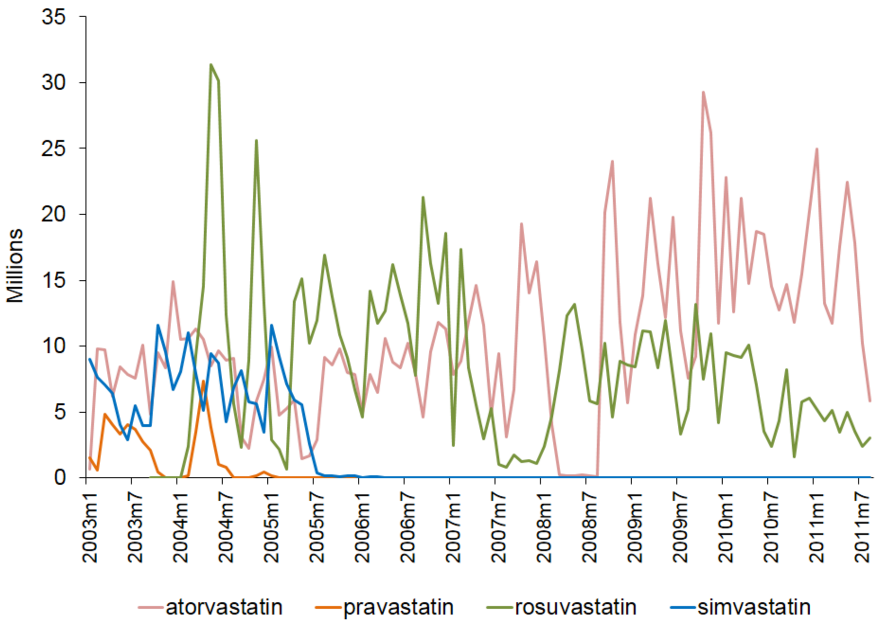

Figure 4: Spending on Direct-to-Consumer Advertising

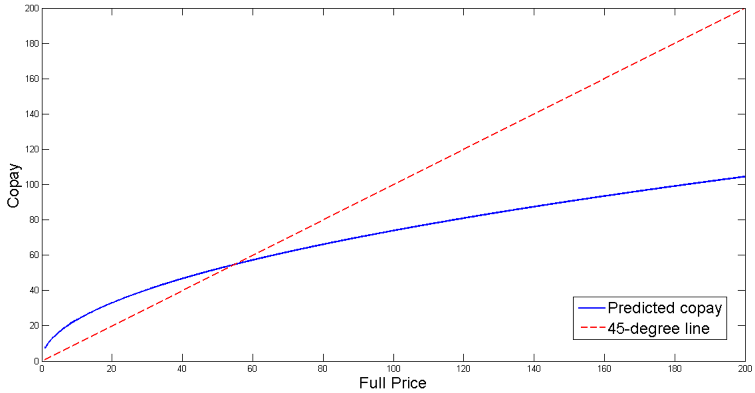

Figure 5: Example: Relationship between Full Price and Copay

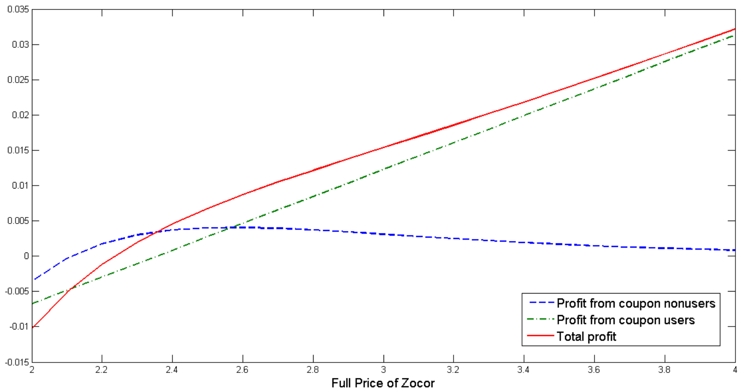

Figure 6: Example: Profit of Merck vs. Zocor's Full Price