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DO PHARMACEUTICAL PRICES RESPOND TO INSURANCE?

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ABSTRACT

Despite the importance of patient insurance in the market for prescription pharmaceuticals, little is known about the impact of insurance on the pricing behavior of pharmaceutical firms. This paper examines the link between insurance and pricing using a unique policy experiment from Germany. Starting in 1989, a maximum reimbursement for a given medicine replaced a flat prescription fee. This change in insurance reimbursement exposes the patient to the price of a prescribed product. Using a product level panel dataset covering several therapeutic categories before and after the change in insurance reimbursement, I find that producers significantly decrease prices after the change in insurance. Price declines are most pronounced for brand name products. Moreover, branded products that face more generic competitors reduce prices more.

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1. Introduction

As governments worldwide try to curb their health care costs, policy debates increasingly focus on the pricing behavior of pharmaceutical firms. Most countries constrain pharmaceutical firms through direct price regulation. Only a few countries, such as the United States and Germany, allow for product level price competition and rely on indirect means to reduce pharmaceutical expenditures. The supporters of price controls justify regulation with the moral hazard problem in prescribing, as physicians might not internalize the cost of a prescription to the patient or the patient's insurance provider. They argue that insurance coverage of prescription pharmaceuticals reduces the sensitivity of physicians and patients to prices. Yet, little is known whether and how patient insurance affects the pricing behavior of pharmaceutical firms. This paper investigates this relation.

To my knowledge, there are no other empirical papers examining the link between patient insurance and pharmaceutical pricing. Several studies provide insights on whether insurance impacts physician and patient behavior and thus demand for medical services. Hellerstein (1998) investigates the physician's prescription decision between brands and generics, motivated by the puzzle that in 1989, less than 30% of prescriptions for multi-source drugs specified the generic version even though "generics are generally priced 30-60% lower than their trade-name counterparts (p. 108)."[2] She finds that the patient's insurance plan does not affect the physician's choice between a brand name and a generic product. However, HMO-affiliated physicians have a higher propensity to prescribe generics irrespective of a patient's insurance plan. This pattern could stem from the cost containment measures imposed on physicians by HMOs. Moreover, studies based on data from the Rand Health Insurance Experiment document that insurance impacts demand for health services. The experiment randomly assigned

[1] Throughout the paper the term Germany refers to the states comprising the Federal Republic of Germany before reunification.

[2] Multi-source drugs are those that are no longer protected by a patent and are available in brand name as well as

different cost-sharing plans to individuals and found that the total expenditure (to all parties) on prescription pharmaceuticals is greater for patients with higher insurance coverage. According to the study, the participants' "expenditures on drugs averaged $65 (in 1991 dollars), ranging from $82 on the free care plan to $46 on the 95 percent coinsurance plan (Newhouse et.al., p. 165)."

Given the impact of insurance on physician and patient behavior, my goal is to explore whether insurance also affects the pricing behavior of pharmaceutical firms. I use a unique policy experiment from Germany. In 1989, Germany implemented reference pricing, a cost containment scheme that imposes a maximum reimbursable price to a patient for a given product.[3] Producers are free to set their prices, but if the retail price exceeds the reference price (RP), the consumer pays the difference.[4] Previously, patients paid only a fixed prescription fee regardless of the prescribed medicine. This change in insurance directly exposes a patient to the price of a medication. The change in insurance modifies the demand conditions in the market and thus alters the markup that pharmaceutical firms charge over marginal cost. I evaluate the relationship between insurance and pharmaceutical prices using a detailed product level data set that spans years before and after the change in insurance and covers several therapeutic groups. My identification relies on the comparison of prices before and after the reform. When data permits, I additionally exploit the lag in the implementation of the reform within a therapeutic group. I then compare the differences in the intertemporal price response of products that compete in a similar environment, but face different timing in the changes in insurance reimbursement. Finally, I investigate whether changes in pricing behavior of pharmaceutical firms can be explained by differences in the competitive pressures firms face.

Germany provides an excellent setting to study the link between insurance and the pricing by pharmaceutical firms. Unlike the US market with many insurance providers, the German statutory health insurance covers over ninety percent of the population and always provides coverage for prescription

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generic versions.

[3]British Columbia, Denmark, the Netherlands, and New Zealand also introduced reference pricing.

[4]I explain the reference pricing scheme and other institutional details of German pharmaceutical market in detail in

drugs. This setting enables me to address the question without detailed patient level data documenting their health insurance plan. Additionally, since everybody has the same insurance coverage there is no selection problem, where people who expect higher medical expenses opt for a more generous insurance plan. Reliance on country level data could pose a problem if prices differed across various regions and purchasing outlets as in the United States. German retail pharmacies are the only place permitted to dispense drugs for outpatient consumers and there is no price variation across them. The government controls the wholesaler's and retailer's margins, and the prices of the pharmaceuticals dispensed by pharmacies are uniform by law.

My results suggest that the pricing behavior of pharmaceutical firms is very sensitive to patient insurance. This finding is robust to different identification strategies and therapeutic markets. The estimates of price adjustment to exogenous change in insurance range from 10 to 30%. Brand name products experience the biggest price decline. The price responses by pharmaceutical firms are partially explained with variation in their exposure to competition. The drop in prices is sharper for those brand name products that face more generic competition. Policy implications of these results are discussed in the conclusion of the paper.

The next section presents institutional background on the German pharmaceutical market and the reference pricing scheme. Section 3 provides theoretical motivation on how changes in insurance might affect the pricing of pharmaceutical products. Section 4 looks at the data and descriptive statistics. Section 5 introduces the empirical strategy and discusses the estimation results. Section 6 concludes.

2. Institutional Background on the German pharmaceutical market

In Germany, the retail pharmacies dispense all outpatient care prescription drugs. These retail pharmacies are the last stage in the distribution of pharmaceuticals from the manufacturer to the patient. Pharmaceutical manufacturers sell their products to the wholesaler. Manufacturers are free to set their prices without government approval before and after the implementation of reference pricing. However,

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section 2.

producers need government approval to launch a new product and must obtain a permit to produce it. Imported drugs must be licensed and can only be handled by a licensed importer. Moreover, a manufacturer must sell the product for the same price in a given time period to all wholesalers. The wholesalers then sell the product to retail pharmacies that deliver it to the patient. The government controls the wholesaler's and retailer's margins. Thus, by law retail pharmacy prices are uniform across the country. [5]

Insurance plays an important role in the transaction between a patient and the retail pharmacist. Over ninety percent of the population is covered by statutory health insurance that always includes coverage for prescription pharmaceuticals. Prior to 1989, patients paid only a fixed prescription fee when purchasing a pharmaceutical product regardless of the retail price. The 1989 reference pricing scheme imposes the maximum reimbursable amount (i.e. reference price) for a given product. If the retail price exceeds the maximum reimbursement, the patient bears the excess cost. Otherwise, the patient does not need to copay. The consumer continues to pay a DM3 prescription fee only for the products not subject to a reference price.[6] The retail pharmacist is reimbursed directly by the insurance based on the prescription obtained from the patient. Unlike in the United States, the pharmacist is not allowed to substitute to a generic product unless the doctor *explicitly* permits it on the prescription pad. The dispensed product must match the strength of the active ingredient, the size, and the dosage of the physician's prescription (Sitzius, pp. 245). I describe how reference prices might affect a physician's prescribing behavior in detail in section 3.

The Federal Commission of Physicians and the Statutory Health Insurance Committee determine reference prices in two stages. In the first stage, they jointly specify the therapeutic groups that should be

[5] The hospital market is completely separate from the retail pharmacy market. Hospitals provide pharmaceuticals only for inpatient care. They purchase either from the wholesaler or directly from the manufacturer, in which case they often receive discounts and rebates. For all these reasons, I do not include them in my analysis.

[6] In 1993, the prescription fee was extended to all products and it depended on the price of a package: DM3 if retail price is less than DM30, DM5 if retail price is between DM30 and DM50, and DM7 if retail price exceeds DM50. Since 1994, prescription fee depends on package size: DM3 for small package, DM5 for medium package, DM7 for large package.

under the reference price system. Thereafter, the insurance committee selects the level of the reference price for the most common package size in a given active ingredient or therapeutic group. The reference prices for other package sizes are then adjusted to accommodate differences in package size and doses (Sullivan, pp. 72). The committee usually sets the reference price below the price of the most expensive brand, but above the prices of the generics. For example, for the case of glibenclamide in 1990, the reference price for a package containing 30 3.5 mg pills was DM9.93, while a brand cost DM12.45 and the generics ranged from DM6.50 upwards. Reference prices are reviewed on an annual basis. Although the scheme was introduced in 1989, its implementation continued throughout the early 1990s. For example, in oral antidiabetic group only the products containing the active ingredient glibenclamide became subject to reference prices in 1989, while some other active ingredients were not covered until 1994. All antiulcerant active ingredients (H2 antagonists), on the other hand, became subject to reference pricing in 1992. Overall, 50% of the sales on the German pharmaceutical market were covered by the reference pricing scheme by July 1993. This significantly falls short of the health ministry's plan to cover 70 to 80% of prescription sales by 1992 (Sullivan, pp. 72-3). By 1996, reference pricing extended to 75% of the market (ABPI 1996).

Overall, the existence of a single insurance scheme covering most of the population, the retail pharmacies as the only outlet for the outpatient pharmaceutical products, the exogenous change in insurance, and the uniformity of prices across the pharmacies make Germany a good setting to study the impact of the insurance on the pharmaceutical pricing.

3. Theory Motivation

The impact of patient insurance on the pricing behavior by pharmaceutical firms can be motivated in a model of demand for pharmaceutical products. Changes in insurance affect the demand conditions prevailing on the market and might alter the markup that pharmaceutical firms charge over marginal cost.

Let us first consider the decision to consume a pharmaceutical product. Hellerstein (1998)

discusses the agency and moral hazard problem in prescribing in detail. The physician acts as an agent for the patient and prescribes the product probably considering her own cost of prescribing and a patient's utility. Based on the prescription, the patient obtains the prescribed medicine from a retail pharmacy as described in section 2 of the paper. A doctor writing a prescription for a patient with a particular illness faces a choice among several alternative treatments (active ingredients) in a given therapeutic group. Additionally, several companies can produce a given active ingredient after patent expiration or under a licensing agreement, providing an option between brands and generics. A pharmaceutical product can thus be viewed as a bundle of characteristics that affects patient well being such as efficacy, safety, reliability, brand name, and price. If a doctor acts as a perfect agent for the patient, the doctor prescribes the product that yields the highest well being for the patient. This choice might be altered if it is costly for a doctor to gather information about product prices or other characteristics.

Patient insurance might affect the doctor's prescription if the doctor considers the patient's well being in prescribing. When patients only perceive a constant prescription fee for all products, the price of a product does not determine the choice of product relative to other characteristics such as efficacy and safety unless the doctor is liable for the reimbursement cost of her prescriptions. The new insurance rules, however, expose the patient to the price p_i of product i if i's price exceeds the maximum reimbursement level p_r. The perceived price that enters the valuation problem is $p_i - p_r$ if $p_i > p_r$ and 0 otherwise. In the setting of this paper, a physician likely considers the product's price in her prescribing decision. Physicians are required by law to inform the patient whether the price of the prescribed product exceeds the reimbursable level, and physicians can obtain price quotes and reference prices in Rote Liste. Rote Liste includes pharmacological information such as dosage, side effects, retail price, and the reference price of pharmaceutical products. It is the most important reference source for physicians prescribing pharmaceuticals (Sitzius, pp. 247). Physicians can then prescribe a product whose price does not exceed the reference price rather than a more expensive product if the quality or reliability

of the two products does not differ substantively. This might particularly affect the pricing of brands relative to generics. If brands in a given active ingredient group face generic competition and their efficacy and reliability do not differ much, the producers of brands might need to decrease their prices to the level of or around the reference price to protect their market share. Therefore, one would expect a differential response for brands and generics to insurance change. The price adjustment also might differ with the level of competition. Products exposed to more competition might be more likely to lower their price than those without many alternatives. I thus explicitly control for competition when I estimate the price responses to changes in insurance in section 5.

4. Data and Descriptive Results

The analysis relies on data on oral antidiabetics and antiulcerants (in particular, H2 antagonists) from IMS Health.[7] The two therapeutic groups are used worldwide to treat widespread illnesses: type II diabetes (oral antidiabetics) and peptic ulcers (antiulcerants). In addition, both therapeutic groups provide a choice of various active ingredients and the choice between brands and generics. The two therapeutic groups differ in that the products in oral antidiabetics have faced generic competition for a while, while generic products only recently entered the antiulcerant market. The data spans eleven years from 1986 to 1996 and covers the area comprising the Federal Republic of Germany before reunification. The original IMS Health database provides quarterly time series information on the value and volume of retail pharmacy sales for each presentation of a given drug produced by a given manufacturer. In each time period, I aggregate over various presentations of a given drug produced by a given manufacturer and define that as a product.[8] An observation is then a product-quarter. Since the reference prices are quoted on the retail level, I perform the analysis with retail prices.[9] For each product, I convert the volume of

[7] This data source has been used in the studies of the US pharmaceutical market such as Ellison et. al. (1997), Scott-Morton (1997), and Stern (1996).

[8] For example, drug named x produced by manufacturer y is sold in packages containing 80 75 milligram (mg) tablets and packages containing 40 150 mg tablets. In each time period, I aggregate the volume (in mg) and revenue data over these two presentations to obtain the volume and value sold of drug named x produced by manufacturer y.

[9] In the original data, sales are reported at the ex-manufacturer's, wholesaler's, and retailer's levels. The government regulates the wholesaler's and retailer's margins, which do not change during the time of my data.

sales to the number of average daily doses sold. I obtain that number by dividing the total quantity sold (in mg) by the average daily dose (in mg) for a specific active ingredient contained in the product.[10] This standardization enables price and quantity comparisons across products with different active ingredients that belong to the same therapeutic group. As is common in this literature (Stern (1996), Ellison et. al (1997), Scott-Morton (1997)) the price is obtained by dividing the value of sales by the volume sold.[11] Since the volume is measured in the number of daily doses sold, prices thus always refer to the price per daily dose. All prices are expressed in 1990 (4th quarter) DM using a price deflator from the Datastream International Database. The data from IMS Health also contains information on a product's active ingredient, manufacturer, launch date, and whether a product is a brand or a generic.[12] Data on reference prices and dates of their implementation are obtained from various issues of Rote Liste. They are also expressed per daily dose. Summary statistics for the variables are provided in Table 1.

The rest of this section illustrates a drop in prices of oral antidiabetics and antiulcerants after the imposition of maximum insurance reimbursement. The fundamental finding that remains robust to all specifications in this paper is evident here: producers significantly reduce their prices after the changes in insurance. Figures 1a and 1b plot the average price of brand name and generic oral antidiabetics affected by reference pricing since 1989 and 1994, respectively. Figures 1a and b display a pronounced drop in the average price of brands that coincides with the introduction of the new insurance scheme in 1989 and 1994, correspondingly. The average price of the generics does not change as much. Figure 1c plots the same information for antiulcerants that received RP in 1992. The average price of brands has been declining over time in general, but does so faster after 1991 when generic products enter the market.

[10] If the average patient requires 2 75mg tablets twice per day, then the average daily dose is 300mg. If a firm sells 80 75mg tablets of a given product, this is equivalent to 20 daily doses sold. Average patient daily doses are obtained from the pharmacological reference Martindale.

[11] Given the disaggregated nature of data and the lack of coupons or rebates, the use of sales revenue per daily dose rather than the actual price is not problematic. Even if I had actual price rather than sales data, I would need to transform it to a measure of price per daily dose to make meaningful comparisons across products.

[12] Brand name products include products marketed by the original firm that patented the active ingredient, their parallel imports, and any brand name product sold by another firm under the terms of a license agreement with the originator. This also includes products that are marketed by the distributor, a company that does not manufacture the product and markets them under the same trade name as the originator.

There is a sharper drop in prices in 1992. The average price of generics also follows the same pattern. Although the decreases in average prices coincide with the implementation of changes in insurance reimbursement, other time varying factors such as the number of generics could affect the prices in the two markets. Given the recent introduction of generic products this poses a particular concern for antiulcerants. Moreover, since 1993 doctors are liable financially if the total cost of their prescriptions exceeds a certain budget. In my estimation I control for this change in various ways, but the results obtained with the data for oral antidiabetics up to 1992 provide the cleanest experiment when assessing the impact of patient insurance on pharmaceutical pricing. Moreover, since the change in 1993 may also lower the prices of pharmaceutical products, it might bias the results that consider changes in insurance in 1994 against finding any impact. In my analysis in section 5, I develop several empirical strategies to control for all these factors in identifying the impact of insurance on firm pricing.

5. Empirical Analysis

5.1 Empirical Implementation

The preliminary evidence from the previous section is consistent with producers reacting to changes in insurance reimbursement. This section proposes several approaches to identify the effect of insurance on the pricing behavior of pharmaceutical firms. Since I observe product level market outcomes before and after the change in insurance, I first focus my analysis only on the variation of prices over time. Consider the following semi logarithmic regression specification

$$\ln(p_{ijt}) = \alpha + \beta\, post_t + \gamma brand_i + \beta_2 (brand_i * post_t) + m_j + \varepsilon_{ijt} \quad (1)$$

where p_{ijt} is the price of a product *i* with an active ingredient j at time *t*, $post_t$ is an indicator whether time t is covered by reference pricing, and m_j is an indicator for whether a product contains an active ingredient *j*. ε_{ijt} could represent a measurement error in prices or unobserved factors that affect prices. $brand_i$ is an indicator whether product *i* has a brand name, and the interaction between $brand_i$ and $post_t$ denotes a brand sold after the imposition of reference prices. Equation (1) captures the institutional features important to pharmaceutical industry. The relevant market consists of products in a therapeutic

group that is used for treatment of a particular disease. I thus estimate equation (1) separately for oral antidiabetics and antiulcerants. Each therapeutic group provides several possible therapeutic alternatives (active ingredients). In order to control for the differences in therapeutic value of available active ingredients, active ingredient indicators are included in all of the regression specifications. Several companies might produce the same active ingredient either after patent expiration or under a licensing agreement. I therefore distinguish between generics and brands. Within this framework, if no uncontrolled factors that affect prices vary before and after the changes in insurance, the coefficient β on the post indicator depicts the impact of changes in insurance on the pricing of firms producing generic products. The interaction between the brand and the post indicator allows the effects of the reimbursement policy to differ for brand-name products. If the coefficient β_2 is negative, the brands lower their prices more after the change in insurance than the generics.

These estimates that rely on the variation of prices before and after the reimbursement change to identify the impact of insurance on pricing might be biased by intertemporal variation not related to changes in insurance such as changes in technology, regulation, or demand. Alternatively, I can compare the pricing of products affected by reference prices, the treatment group, to a control group of products subject to the same technology, regulatory, and demand shocks as the treatment group, but not subject to reference pricing. Because of the lag in the implementation of reference pricing (RP), some active ingredients in oral antidiabetics did not face RP until 1994, and they represent a good control for products with RP since 1989. Similarly, products without RP in 1994 present a control for oral antidiabetics with RP since 1994. I estimate the following specification:

$$\ln(p_{ijt}) = \alpha + \beta\, post_t + \mu rp_i + \gamma brand_i + \delta(rp_i * post_t) + \lambda_1(brand_i * post_t) + \lambda_2(brand_i * rp_i) + \delta_2(rp_i * brand_i * post_t) + m_j + \varepsilon_{ijt} \quad (2)$$

where indicator rp_i denotes whether a product *i* belongs to the treatment group--products subject to a reference price. All other notation follows that of (1). In this setting the variable *post* controls for factors that change concurrently with the change in insurance and affect products with and without

reference prices. The coefficient on the interaction of the indicator for products with a reference price rp_i and *post*, δ, is the estimate of the impact of the changes in insurance on generics. The coefficient on the interaction of the reference price indicator *rp*, brand indicator *brand*, and *post*, δ_2, is the estimate of the additional insurance impact on the pricing of brands.

An alternative way to study the effect of insurance on pharmaceutical pricing is to relate product prices to the actual insurance reimbursement levels, i.e. reference prices, using observations after the implementation of insurance reform.[13] Table 2 reports the results of regressing prices on reference prices (both in logs) for oral antidiabetics and antiulcerants. The regressions always include active ingredient indicators and either a time trend or year indicators, and they are estimated using product random effects.[14] The results suggest that producers respond sharply to changes in patient reimbursement. Conditional on the product having a reference price, a drop in reimbursement leads to a significant decline in prices. The elasticity estimates are around .3 for oral antidiabetics, suggesting that as reimbursement declines by 10%, prices drop by 3%. The estimates range from .1 to .16 for antiulcerants. Overall, this approach only uses the observations after the implementation of the reform and might be more believable if there is significant variation in reimbursement levels over time. In my data, the observations do not span a long time frame after the insurance change. For example, for many oral antidiabetics I only have 2 years of observations. Also, although reference prices are reviewed on an annual basis, their levels often do not change at all or by much in practice. In oral antidiabetics no major adjustment occurred between 1989 and 1994, while reference prices changed quite significantly for some antiulcerants in 1994 and 1996. I thus do not incorporate the actual reimbursement level in the rest of the analysis and rely on price variation before and after the implementation of insurance changes.

[13] The observations dating prior to reference pricing cannot be used in the analysis. The reimbursement level equals the product's price prior to the imposition of reference pricing, so the dependent variable would appear as an explanatory variable. Rather than including the reference price level directly one could use the patient's required payment. Since the payment equals the actual product price less the reference price after the imposition of RP, this would force one to include the product's price (the depended variable) as a regressor for observations in periods with reference prices. Moreover, patient's required payment was constant across time and products prior to RP.

[14] Hausman tests fail to reject that the regressors are not correlated with the error term in all cases.

5.2 Empirical Results

I begin by discussing several estimation issues before presenting the results of (1) and (2). First, my data consists of repeated observations on the same product *i* over time, so I need to adjust standard errors for the correlation in the error terms across observations on product i. A time invariant unobserved product characteristic (such as unobserved quality) that affects prices might be correlated also with regressors. Hausman tests fail to reject that the regressors are not correlated with the error term in all of the reported regressions in this paper, so the random effects estimation (a GLS estimator allowing for correlation in errors for the same product across different periods) yields consistent and efficient estimates of the coefficients. All of the reported results in the paper use this specification.

Second, my analysis relies on intertemporal variation before and after the change in insurance. In order to check the robustness of my results to unobserved time varying factors that impact prices, I compare results without time controls to results with a time trend and results with year indicators in (1) and (2). Without time controls, I attribute all uncontrolled intertemporal variation in prices before and after the reform to changes in insurance. The second approach of including a time trend assumes that changes in insurance lead to a price shift but do not affect the price trend. The third approach with year indicators identifies the effect of insurance using the average variation in prices before and after the reform.

I first focus the discussion of results on oral antidiabetics. They present a relatively stable and established market during my sample. The first active ingredient was introduced in the 1940s. Thus, they are less likely to incur significant changes in the competitive environment or technological shocks concurrently with insurance changes. Table 3 reports the estimates of (1) for oral antidiabetics with various time controls. Columns 1-3 do not distinguish between brands and generic products. If all uncontrolled factors affecting prices remain constant before and after the change in insurance, the coefficient on the post indicator depicts the average percentage change in prices as a result of changes in insurance. The negative coefficients in columns 1-3 suggest that pharmaceutical prices drop significantly

after the change in insurance. The estimates range from 15 to 23%.

Because of the gradual implementation of new insurance rules for oral antidiabetics, I am able to estimate the impact of insurance relying on both variation over time and a control group as in (2). As mentioned earlier, some active ingredients in oral antidiabetics do not face RP until 1994, and they represent a good control group for products with RP since 1989. Similarly, products still without RP in 1994 present a control for oral antidiabetics with RP since 1994. These results are reported in table 4. Column 2 of table 4 reports the estimates of equation (2) for oral antidiabetics subject to maximum reimbursement since 1989 using observations up to 1992. Prices declined on average by 10.9% as a result of the 1989 insurance change. This estimate is very close to the one obtained in the simple before and after analysis reported in column 1 (-9.5%). Similar findings are obtained for oral antidiabetics subject to new insurance rules since 1994 reported in columns 5 and 6 using observations from 1992 to 1996. There, the estimated impact of insurance relying on control group (-26.1%) is lower than the estimate based on the intertemporal variation (-34.4%). These findings persist when the regressions include no time controls or a time trend. The results are presented in appendix tables 1 and 2, respectively.

Figures 1a and 1b and the theoretical motivation in section 3 of the paper suggest that brands and generic products might adjust differentially to insurance changes. Columns 4-6 of table 3 report estimates of equation (1) differentiating between generic products and brands using various time controls. Brands reduce their prices significantly more than generics. For example, column 6 indicates that the prices of generic products decline on average by 11.5% after the change in insurance. Although the prices of brands are on average 52.7% higher than those of generics prior to changes in insurance, the brand premium declines after the reform. The prices of brands drop on average by an additional 25.9%. These finding are robust to the inclusion of a control group as in (2). The estimates of (2) for oral antidiabetics subject to new insurance rules since 1989 (1994) are reported in column 4 (column 8) of table 4. They are close to those obtained by the simple before and after analysis reported in column 3

(column 7). For example, column 3 and 4 both suggest that the generic products drop their prices by 5.7% as a result of insurance change in 1989. When I rely on a control group in column 4, the estimate suggests that brands decrease prices by an additional 33.6% after the change in insurance. This is close to the estimate of 29.5% relying solely on intertemporal variation in column 4.[15]

Overall, my results suggest that prices respond sharply to declines in insurance reimbursement. My estimates also confirm the anecdotal evidence that reimbursement changes affect brands and generics differently. Zweifel and Crivelli (1996) suggest that the reform produced an immediate decline in prices of innovators to the reference price level, but had little impact on generic prices, which were already below the reimbursement ceiling. Sullivan (1993), on the other hand, claims that generic producers increased prices so that the reform decreased price competition. This could, for example, occur if changes in insurance facilitate collusion among generic producers by providing a focal point, from which firms are less likely to deviate. I find that the prices of generic products drop in most cases, but that the drop is on average much more pronounced for brands. This suggests that producers need to significantly decrease the premium for a brand name product to protect their market shares as patients actually perceive the price of a product.

As oral antidiabetics are a market with no major changes in competitive environment, the estimates of the relationship between insurance and price are not very sensitive to whether and how I control for other time varying variables. Antiulcerants, however, have undergone significant changes in market environment. Generic products only enter the market in 1991, a year prior to insurance change and the increased presence of generic products might impact prices independently of insurance changes. The estimates of the link between insurance and pricing that do not control for generic competition are unsurprisingly less robust than those for oral antidiabetics. For example, table 5 reports the estimates of a version of (1) for antiulcerants using various time controls. The coefficients on post indicator vary significantly across specification with different time controls. The decrease in prices range from 46%

[15] Appendix tables 1 and 2 show that these results are robust to inclusion of a time trend or no time controls.

when all intertemporal variation is attributed to changes in insurance, to 12% when we include year indicators, to none when a time trend is included. Moreover, the coefficient on post indicator is sensitive to the choice of the base year when I include year indicators. Since all antiulcerants became subject to the maximum reimbursement level at the same time in 1992, I need to exclude two year indicators. In column 3, I exclude the year prior to the implementation of the reform (1991) and the first year of the reform (1992), which is equivalent to renaming the year indicator for the initial year of insurance change as post. The effect of insurance (the coefficient on post) is thus identified solely by the variation in prices in the first year of the reform relative to the previous year. Column 4, on the other hand, excludes the initial year of the sample (1986) and the first year of the reform, so that the coefficient on post is identified by the variation in prices in the first year of the reform relative to the initial year of the sample. Unsurprisingly, the coefficient in column 4 (-.27) exceeds the estimated effect of insurance in column 3 (-.12). Given these caveats, I explicitly incorporate the changes in competition in section 5.3 in the analysis of insurance and pricing for antiulcerants.

5.3 Competition

In this section I first check whether the decline in prices of pharmaceutical products after the change in insurance persists when I directly control for the competitive environment. I then examine whether the differences in competition products face elucidate the differential response of products to changes in insurance. I control for competition by augmenting equation (1) with a variable measuring the number of generics in the active ingredient group. This measure of competition has been, for example, used by Scott-Morton (1997). I also interact number of generics with the post indicator and a brand indicator to allow differential impact of competition before and after changes in insurance and for brands. The number of generics facing a product in a given active ingredient group could be a function of a product's price. For example, more generics might enter the market segment with higher prices because of higher anticipated profits. Also, there might be unobserved factors that affect product prices and generic entry. Hence, to identify the effect of generic competition on price, I need variables that

affect a producer's ability to enter a pharmaceutical market that do not directly affect the prices of existing products. The endogeneity problem in the case of this paper is mitigated because the entry of generics is determined by past prices and patent expiration dates as it takes time to acquire a production permit or an importer's license. Also, if the endogeneity issue arises because higher prices lead to greater entry of generics, this suggests a positive correlation between prices and generic competition. If we are interested in whether additional generic competition lowers prices, this form of a bias attenuates the true effect and might result in a false rejection of the hypothesis. Alternatively, if the endogeneity arises from an unobserved time-invariant characteristic affecting both prices and competition, the product fixed effects estimation would yield unbiased estimates. Using a Hausman test, I do not reject the hypothesis that the regressors are not correlated with the error term, and I therefore continue using a random effects model.

The estimates of equation (1) augmented with the number of generics are reported in table 6 for antiulcerants. This table controls for the unobserved time-varying factors with year indicators and relies on the variation in prices in the initial year of the reform relative to the year preceding the reform. Appendix tables 3, 4, and 5 estimate the augmented equation (1) using no additional time controls, adding a time trend, and adding year indicators and using 1986 as a base year. After controlling for generic competition, the findings across the specifications with various time controls do not differ, so I focus my discussion on table 6. Columns 1-4 of table 6 report the results based on all antiulcerant products. In columns 5-12, I check the robustness of results using only products containing the active ingredient that became subject to generic competition in 1991.

The comparison of the effect of insurance in columns 1 and 2 illustrates the importance of controlling for generic competition in this changing market. Column 1 suggests that prices declined on average by 11.5% after the change of insurance and that brands did not change their prices differently from generics. Conditioning on the number of generics in column 2 halves the impact of insurance on prices to around 5.8%. Similar pattern is obtained in columns 5 and 6 using only products with the active

ingredient subject to generic competition since 1991. Overall, conditional on the number of generic products, the 1992 change in insurance does not impact product prices significantly. Moreover, the negative coefficient on the number of generics in column 2 and 6 suggests that additional generic competition lowers prices. One could argue that it is difficult to pinpoint the impact of the 1992 insurance change even after controlling for generic competition given that the generic products entered the market in 1991. Products containing the active ingredient with generic competition since 1991 also experienced a large reduction in the assigned reference price in 1994. By then, more generic competition existed. In columns 9-12, I focus on the 1994 insurance change using data for 1992 to 1996. The post indicator is thus one if the time period is covered by the 1994 insurance change and zero otherwise. Column 9 suggests a decline in the price of generics and an additional decline in the price of brands after the reimbursement change. Conditional on the number of generics, the price of a generic product actually increases on average after the change in insurance, while insurance has a small negative impact on the pricing of brands (column 10). Table 7 repeats the above analysis for oral antidiabetics.[16] The impact of insurance on the pricing of generics and brands continues to persist even after controlling for the number of generics. For example, the estimates of the impact of insurance in column 1 are very close to those in column 6 of table 3 that do not explicitly control for generic competition.

Given the importance of generic products in the antiulcerant market, I next check whether generic competition influences the price response of products to changes in insurance. If products lower their prices because they effectively face more price competition from generics after the changes in insurance, the coefficient on the interaction between the number of generics and the post indicator should be negative. The results for antiulcerants in table 6 support this hypothesis. Columns 3, 7, and 11 allow the number of generics to affect prices differently before and after the insurance change. Columns 7 and 11 indicate that everything else equal, the additional generic competition lowers product prices more after the change in insurance. The coefficient on the interaction of post and the number of generics is

[16] Appendix table 6 repeats the analysis for oral antidiabetics with a time trend or with no time controls. The

negative.[17] The importance of generic competition is even more pronounced for brands: the coefficient on the interaction of post indicator, brand, and the number of generics is always negative and significant (columns 4, 8, 12). This finding is also confirmed in column 3 of table 7 for oral antidiabetics. After the changes in insurance, the brands are no longer able to change as high of a brand premium as when all the products are subject to a constant prescription fee. The brands facing more generic competition reduce their price premium by more after the change in insurance.[18]

Given the large price response to changes in insurance found in this paper, it is interesting to observe a lack of response in the quantity of products sold. Table 8 reports estimates of (1) with quantities as a dependent variable. The coefficient on the post variable is insignificant for oral antidiabetics and antiulcerants in column 1 and 3. Moreover, while the quantity sold for generics on average stays the same (oral antidiabetics) or increases (antiulcerants), the quantity sold of brands on average declines after changes in insurance. This confirms that the producers of brand name products have an incentive to lower prices to shield their market share. Although the change in insurance alters the mix of quantities sold between generics and brand name products, it does not halt the growth in the overall market size. Figures 2a and 2b trace the total quantity sold (measured in number of daily doses sold) over time in the oral antidiabetics and antiulcerant market, respectively. Both markets in general continue to grow despite the cost containment measures. For example, although the sales of oral antidiabetics drop sharply right after the change in insurance in 1989, the quantities recover shortly thereafter. The initial decline is likely due to the sluggish price adjustment in the first two quarters of 1989 observed in Figure 1a. No such sharp quantity response is evident after the insurance changes for

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conclusions are the same.

[17] In column 3, the additional generic competition lowers prices, but this effect is not significantly different before and after the insurance change.

[18] As a robustness check, I have repeated the analysis in tables 6 and 7 using a Herfindahl index as a measure of competition in an active ingredient group. A market segment with a higher Herfindahl index is more concentrated and less competitive. The Herfindahl index and the number of generics in a given active ingredient group are thus likely inversely related. Given that the correlation between the Herfindahl index and the number of generics is -.89 for oral antidiabetics and -.86 for antiulcerants, it is not surprising that the estimates based on the Herfindahl index yield the same conclusions.

oral antidiabetics in 1994 (figure 2a) and for antiulcerants in 1992 (figure 2b). The lack of response might imply that producers have learnt about the price sensitivity of patients from 1989 changes in insurance and lower their prices immediately after the subsequent reimbursement adjustments.

6. Conclusion

This paper examines a unique episode of exogenous changes in insurance to assess the link between insurance and pricing behavior by pharmaceutical firms. I find that producers significantly reduce prices as the change in insurance reimbursement directly exposes patients to prices. Depending on the therapeutic group and specification, the estimates of price reductions due to changes in insurance range from 10 to 30%.

Generic competition seems to play an important role in this process. The changes in reimbursement mostly affect price competition between brands and generics within the same active ingredient group. Brands reduce their prices on average by 13 to 30% more than generics, and the price drop is bigger for brands containing an active ingredient facing more generic competition. This corroborates the findings by Ellison et. al. (1997) that the relevant competition in the pharmaceutical market occurs between generics and the brand name version of the same active ingredient rather than across products that are therapeutics substitutes, i.e. products with different active ingredients, but belonging to the same therapeutic group. Their model of pharmaceutical demand yields high estimates of cross-price elasticities among generics and brands with the same active ingredient and low estimates of cross-price elasticities between products with different active ingredients. The lack of competition between therapeutic substitutes is also found by Scott-Morton (1997). She investigates how the OBRA legislation affects the pricing by pharmaceutical firms in the US market.[19] Scott-Morton finds the legislation does not substantively alter the pricing of patented products because of relatively weak competition from their therapeutic substitutes.

[19] The legislation requires that the pharmaceutical firms give Medicaid price discounts based on the lowest (or at times average) price that other buyers negotiate with pharmaceutical firms. The theory predicts that the law should diminish the firm's incentives to lower prices for more price sensitive consumers, because the firm must extend such

Moreover, my results strongly suggest that patients and doctors are sensitive to insurance. Recent studies of pharmaceutical demand abstract from insurance coverage. A more explicit treatment of insurance in these empirical models might be a fruitful area for future research.

Most importantly, this paper shows that changes in patient insurance spillover to the pharmaceutical producers. This channel should not be ignored when discussing the implications of expanding health insurance coverage. For example, recent debates in the United States about whether Medicare should cover outpatient prescription pharmaceuticals often conclude with demands for the direct price regulation of pharmaceuticals. Public interest in these debates in not surprising given that pharmaceuticals account for 30 percent of out-of pocket expenditures for health services in the United States in 1992, and the elderly account for 35 percent of total drug consumption (Schweitzer 1997). A carefully designed insurance reimbursement scheme for outpatient pharmaceuticals might provide an alternative to direct price regulation. However, lower prices might dissuade pharmaceutical firms from cross subsidizing research intensive activities as the producers might be less likely recoup their R&D investment. Clearly, future research should identify this tradeoff between lower pharmaceutical prices and R&D investment.

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benefits to Medicaid.

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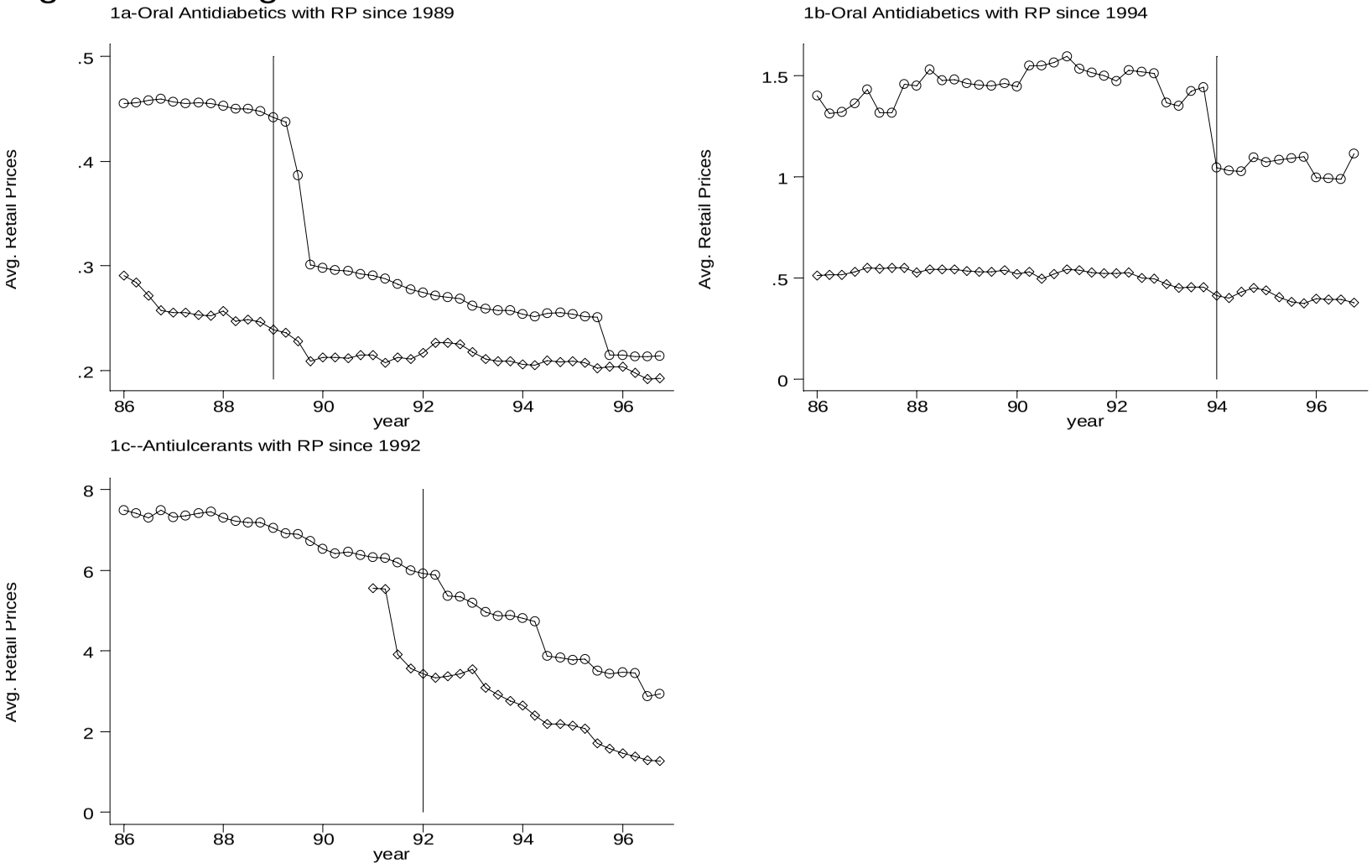
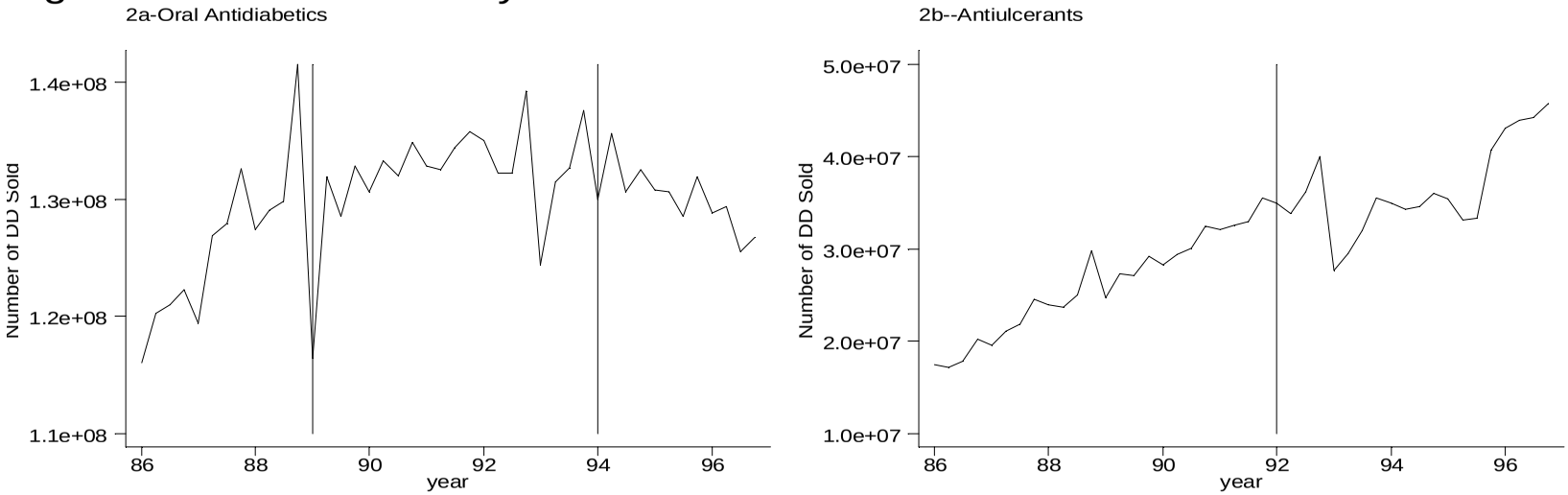
Figure 1-Average Price of Brands and Generics with RP



circle—brands, diamond—generics

Note: The vertical line depicts the year insurance changed for a given product.
Source: IMS Health, Rote Liste, author's own calculations.

Figure 2-- Number of Daily Doses Sold



Note: The vertical line depicts the year RPs were introduced for a given product.
Source: IMS Health, Rote Liste, author's own calculations.

Table 1--Summary Statistics

Variable	N	Mean	S.D.	Min	Max
Oral Antidiabetics					
Price of Average Daily Dose	2051	0.49	0.45	0.07	2.26
Share of Brands	2051	0.24	0.43	0	1
Number of Generics per Active Ingredient	374	6.53	9.65	0	32
Antiulcerants					
Price of Average Daily Dose	1347	4.10	2.22	0.72	8.37
Share of Brands	1347	0.58	0.49	0	1
Number of Generics per Active Ingredient	193	2.95	7.28	0	29

Note: Prices in 1990 DM. Source: IMS Health, CPI is from Datastream. N is the number of quarter-products. N is the number of quarter-active ingredients in the case of the number of generics per active ingredient.

Table 2--The Effect of Insurance Reimbursement on Pricing

(dependent variable is log retail price)

	Oral Antidiabetics		Antiulcerants	
	(1)	(2)	(3)	(4)
ln(reference price)	.289 **	.328 **	.105 **	.164 **
	(.101)	(.116)	(.050)	(.070)
Year indicators	no	yes	no	yes
Time trend	yes	no	yes	no
Active Ingredient Indicator	yes	yes	yes	yes
N	1029	1029	941	941

Note: Standard errors are in parenthesis. ** and * indicate significance at a 5% and 10% level, respectively. All regressions are estimated using product random effects. Retail prices and reference prices are measured per average daily dose.

Table 3--The Effect of Insurance on Pricing for Oral Antidiabetics

(dependent variable is log retail price)

	(1)	(2)	(3)	(4)	(5)	(6)
Post	-.229 **	-.150 **	-.187 **	-.169 **	-.085 **	-.115 **
	(.010)	(.016)	(.019)	(.012)	(.017)	(.019)
Brand (yes=1)				.515 **	.537 **	.527 **
				(.168)	(.163)	(.160)
Brand*Post				-.284 **	-.280 **	-.259 **
				(.024)	(.024)	(.024)
Year indicators	no	no	yes	no	no	yes
Time trend	no	yes	no	no	yes	no
Active Ingredient Indicators	yes	yes	yes	yes	yes	yes
N	1834	1834	1834	1834	1834	1834

Note: Retail prices are expressed per daily dose and measured in 1990 DM. Standard errors are in parenthesis. ** and * indicate significance at a 5% and 10% level, respectively. All regressions are estimated using product random effects. The indicator variable post is 1 for 1989 and after except for products that become subject to reference prices in 1994. For these products the post indicator is zero through 1993. Brand is one if product has a brand name and zero otherwise. 1986 is the omitted year indicator.

Table 4--The Effect of Insurance on Pricing for Oral Antidiabetics with reference prices since 1989 or 1994

(dependent variable is log retail price)

	RP since 1989 using 1986-1992				RP since 1994 using 1992-1996			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
post	-.095 **	.000	-.057 **	-.014	-.344 **	-.095 **	-.262 **	-.085
	(.023)	(.017)	(.023)	(.018)	(.038)	(.051)	(.044)	(.067)
RP (yes=1)		-1.644 **		-1.070 **		-1.965 **		-.409 **
		(.390)		(.118)		(.374)		(.160)
RP *post		-.109 **		-.057 **		-.261 **		-.189 **
		(.015)		(.018)		(.051)		(.069)
brand (yes=1)			.733 **	.713 **			1.185 **	.366
			(.266)	(.150)			(.191)	(.256)
brand*post			-.295 **	.020 *			-.181 **	.821 **
			(.037)	(.291)			(.051)	(.300)
RP*brand				.040				-.012
				(.023)				(.090)
RP*brand*post				-.336 **				-.170 *
				(.037)				(.100)
Year indicators	yes	yes	yes	yes	yes	yes	yes	yes
Active ingredient indicators	na	yes	na	no	yes	yes	no	no
N	726	1272	726	1272	304	429	304	429

Note: Retail prices are expressed per daily dose and measured in 1990 DM. Standard errors are in parenthesis. ** and * indicate significance at a 5% and 10% level, respectively. All regressions are estimated using product random effects. Post is one if the time period is after the imposition of reference prices. In columns 1-4, the indicator variable post is one if the time period is after the imposition of reference prices (1989 and after). In columns 5-8, the indicator variable post is one if the time period is after the imposition of reference prices (1994 and after). RP is one if the product belongs to the treatment group. So, RP is one if the product is covered by reference prices since 1989 (columns 1-4) , or by reference prices since 1994 (columns 5-8). Brand is one if product has a brand name and zero otherwise.

Table 5--The Effect of Insurance on Pricing for Antiulcerants

(dependent variable is log retail price)

	(1)	(2)	(3)	(4)
Post	-.463 **	.010	-.122 **	-.274 **
	(.016)	(.021)	(.021)	(.030)
Year indicators	no	no	yes	yes
Time trend	no	yes	no	no
Active Ingredient Indicators	yes	yes	yes	yes
N	1347	1347	1347	1347

Note: Retail prices are expressed per daily dose and measured in 1990 DM. Standard errors are in parenthesis. ** and * indicate significance at a 5% and 10% level, respectively. All regressions are estimated using product random effects. The indicator variable post is 1 for 1992 and after. Brand is one if product has a brand name and zero otherwise. The omitted year indicators in column 3 are 1991 and 1992. The omitted year indicators in column 4 are 1986 and 1992.

Table 6--The effect of insurance on pricing for Antiulcerants

(dependent variable is log retail price)

	RP in 1992 (all products 1986-1996)				RP in 1992 (1986-1996)				RP in 1994 (1992-1996)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
post	-.115 **	-.058 *	-.076	-.550 **	-.101 **	-.027	.176 **	-.353 **	-.108 **	.116 **	1.174 **	1.004 **
	(.037)	(.035)	(.050)	(.125)	(.037)	(.037)	(.074)	(.130)	(.025)	(.041)	(.213)	(.225)
brand (yes=1)	.910 **	.909 **	.898 **	.464 **	.702 **	.617 **	.656 **	.210 *	.725 **	.714 **	.718 **	.646 **
	(.057)	(.056)	(.060)	(.130)	(.081)	(.082)	(.084)	(.143)	(.072)	(.072)	(.072)	(.128)
brand*post	-.005	-.034	-.022	.482 **	-.069 *	.012	-.028	.651 **	-.137 **	-.131 **	-.138 **	.333 **
	(.040)	(.038)	(.044)	(.127)	(.042)	(.042)	(.044)	(.130)	(.032)	(.030)	(.030)	(.205)
Number of generics (ngen)		-.011 **	-.013 **	-.064 **		-.025 **	-.013 **	-.064 **		-.033 **	-.016 **	-.019 **
		(.001)	(.004)	(.014)		(.003)	(.005)	(.014)		(.005)	(.006)	(.007)
ngen*post			.002	.056 **			-.021 **	.035 **			-.051 **	-.044 **
			(.004)	(.014)			(.007)	(.014)			(.010)	(.011)
ngen*brand				.055 **				.059 **				.006
				(.015)				(.015)				(.008)
ngen*post*brand				-.059 **				-.069 **				-.021 **
				(.015)				(.015)				(.010)
Active Ingredient Indica	yes	yes	yes	yes	na	na	na	na	na	na	na	na
Year Indicators	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	1347	1347	1347	1347	882	882	882	882	646	646	646	646

Note: Retail prices are expressed per daily dose and measured in 1990 DM. Standard errors are in parenthesis. ** and * indicate significance at a 5% and 10% level, respectively. All regressions are estimated using product random effects. Columns 1-4 are estimated using all antiulcerants. Columns 5-12 are estimated using only products with the active ingredient that had generic competitors since 1991. This is the same active ingredient that underwent a significant decline in reference price in 1994. Columns 1-8 consider the effect of insurance change in 1992 on pricing using data from 1986 to 1996. For those columns, the indicator variable post is 1 for 1992 and after. The omitted year indicators in columns 1-8 are 1991 and 1992, so that the effect of insurance is identified with the variation in prices in 1992 relative to 1991. Columns 9-12 consider the impact of additional change in insurance for the active ingredient in question in 1994 using data from 1992 to 1996. For those columns, the indicator variable post is 1 for 1994 and after. The omitted year indicators in columns 9-12 are 1993 and 1994, so that the effect of insurance is identified with the variation in prices in 1994 relative to 1993. Brand is one if product has a brand name.

Table 7--The effect of insurance on pricing for Oral Antidiabetics

(dependent variable is log retail price)

	(1)	(2)	(3)
post	-.131 **	-.260 **	-.552 **
	(.020)	(.036)	(.048)
brand (yes=1)	.509 **	.446 **	.857 **
	(.163)	(.162)	(.337)
brand*post	-.243 **	-.173 **	.198 **
	(.025)	(.030)	(.051)
Number of generics (ngen)	.011 **	-.007	-.019 **
	(.004)	(.006)	(.006)
ngen*post		.007 **	.020 **
		(.002)	(.002)
ngen*brand			-.009
			(.012)
ngen*post*brand			-.018 **
			(.003)
Active Ingredient Indicators	yes	yes	yes
Year Indicators	yes	yes	yes

Note: Retail prices are expressed per daily dose and measured in 1990 DM. Standard errors are in parenthesis. ** and * indicate significance at a 5% and 10% level, respectively. All regressions are estimated using product random effects. The indicator variable post is 1 for 1989 and after except for products that obtain RP in 1994. For these products the post indicator is zero through 1993. Brand is one if product has a brand name and zero otherwise. N is 1834.

Table 8--The Effect of Insurance on Quantity Sold

(dependent variable is log quantity sold)

	Oral Antidiabetics		Antiulcerants		
	(1)	(2)	(3)	(4)	(5)
Post	-.013	.124	-.144	1.754 **	1.467 **
	(.082)	(.087)	(.207)	(.328)	(.394)
Brand (yes=1)		.248		.861 *	1.563 **
		(1.092)		(.523)	(.743)
Brand*Post		-.492 **		-1.987 **	-2.298 **
		(.109)		(.269)	(.307)
Year indicators	yes	yes	yes	yes	yes
Active Ingredient Indicators	yes	yes	yes	yes	na
N	1834	1834	1347	1347	882

Note: Quantity is measured in number of daily doses sold. Standard errors are in parenthesis. ** and * indicate significance at a 5% and 10% level, respectively. All regressions are estimated using product random effects. For oral antidiabetics, the indicator variable post is 1 for 1989 and after except for products that obtain RP in 1994. For these products the post indicator is zero through 1993. For antiulcerants, the indicator variable post is 1 for 1992 and after. Brand is one if product has a brand name and zero otherwise. Column 5 only includes products containing the active ingredient with generics in 1991. The omitted year indicators in columns 3-5 are 1986 and 1992.

Appendix Table 1--The Effect of Insurance on Pricing for Oral Antidiabetics with reference prices since 1989 or 1994 using no time controls

(dependent variable is log retail price)

	RP since 1989 using 1986-1992				RP since 1994 using 1992-1996			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
post	-.126 **	-.018	-.089 **	-.031 **	-.303 **	-.051	-.248 **	-.033
	(.013)	(.012)	(.013)	(.015)	(.024)	(.033)	(.028)	(.041)
RP (yes=1)		-1.640 **		-1.073 **		-1.776 **		-.370 **
		(.402)		(.121)		(.321)		(.116)
RP *post		-.109 **		-.058 **		-.254 **		-.218 **
		(.015)		(.018)		(.033)		(.042)
brand (yes=1)			.733 **	.709 **			1.029 **	.380 *
			(.281)	(.153)			(.153)	(.207)
brand*post			-.297 **	.025			-.123 **	.650 **
			(.037)	(.298)			(.032)	(.244)
RP*brand				.037				-.027
				(.023)				(.064)
RP*brand*post				-.334 **				-.096
				(.037)				(.070)
Year indicators	no	no	no	no	no	no	no	no
Active ingredient indicators	na	yes	na	no	yes	yes	no	no
N	726	1272	726	1272	304	429	304	429

Note: Retail prices are expressed per daily dose and measured in 1990 DM. Standard errors are in parenthesis. ** and * indicate significance at a 5% and 10% level, respectively. All regressions are estimated using product random effects. Post is one if the time period is after the imposition of reference prices. In columns 1-4, the indicator variable post is one if the time period is after the imposition of reference prices (1989 and after). In columns 5-8, the indicator variable post is one if the time period is after the imposition of reference prices (1994 and after). RP is one if the product belongs to the treatment group. So, RP is one if the product is covered by reference prices since 1989 (columns 1-4) , or by reference prices since 1994 (columns 5-8). Brand is one if product has a brand name and zero otherwise.

Appendix Table 2--The Effect of Insurance on Pricing for Oral Antidiabetics with reference prices since 1989 or 1994 using a time trend

(dependent variable is log retail price)

	RP since 1989 using 1986-1992				RP since 1994 using 1992-1996			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
post	-.094 **	.001	-.061 **	-.015	-.222 **	.025	-.141 **	.041
	(.024)	(.017)	(.024)	(.019)	(.047)	(.054)	(.052)	(.069)
RP (yes=1)		-1.078 **		-1.071 **		1.851		-.405 **
		(.404)		(.121)		(1.163)		(.156)
RP *post		-.109 **		-.058 **		-.264 **		-.199 **
		(.015)		(.018)		(.051)		(.069)
brand (yes=1)			.732 **	.710 **			1.179 **	.372
			(.285)	(.152)			(.185)	(.249)
brand*post			-.296 **	.023			-.181 **	.806 **
			(.037)	(.296)			(.052)	(.293)
RP*brand				.038				-.025
				(.023)				(.091)
RP*brand*post				-.334 **				-.157
				(.037)				(.101)
Time Trend	yes	yes	yes	yes	yes	yes	yes	yes
Active ingredient indicators	na	yes	na	no	yes	yes	no	no
N	726	1272	726	1272	304	429	304	429

Note: Retail prices are expressed per daily dose and measured in 1990 DM. Standard errors are in parenthesis. ** and * indicate significance at a 5% and 10% level, respectively. All regressions are estimated using product random effects. Post is one if the time period is after the imposition of reference prices. In columns 1-4, the indicator variable post is one if the time period is after the imposition of reference prices (1989 and after). In columns 5-8, the indicator variable post is one if the time period is after the imposition of reference prices (1994 and after). RP is one if the product belongs to the treatment group. Thus, RP is one if the product is covered by reference prices since 1989 (columns 1-4) , or by reference prices since 1994 (columns 5-8). Brand is one if product has a brand name and zero otherwise.

Appendix Table 3--The effect of insurance on pricing for Antiulcerants--Robustness Check

(dependent variable is log retail price)

	RP in 1992 (all products 1986-1996)				RP in 1992 (1986-1996)				RP in 1994 (1992-1996)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
post	-.384 **	-.081 **	-.083	-.284 **	-.384 **	.027	.191 **	-.277 **	-.315 **	.173 **	.941 **	.779 **
	(.047)	(.038)	(.051)	(.138)	(.051)	(.037)	(.051)	(.128)	(.024)	(.035)	(.100)	(.123)
brand (yes=1)	1.156 **	.988 **	.985 **	.637 **	.872 **	.547 **	.660 **	.278 **	.747 **	.705 **	.717 **	.647 **
	(.091)	(.071)	(.075)	(.145)	(.112)	(.080)	(.083)	(.144)	(.073)	(.071)	(.071)	(.127)
brand*post	-.076	-.071 *	-.070	.093	-.131 **	.087 **	-.030	.546 **	-.131 **	-.115 **	-.137 **	.339 *
	(.050)	(.038)	(.049)	(.139)	(.056)	(.039)	(.046)	(.134)	(.038)	(.031)	(.030)	(.205)
Number of generics (ngen)		-.024 **	-.025 **	-.064 **		-.033 **	-.017	-.064 **		-.043 **	-.020 **	-.022 **
		(.001)	(.004)	(.016)		(.001)	(.004)	(.014)		(.003)	(.004)	(.005)
ngen*post			.000	.033 **			-.018 **	.033 **			-.040 **	-.033 **
			(.004)	(.016)			(.004)	(.015)			(.005)	(.006)
ngen*brand				.043 **				.050 **				.005
				(.016)				(.015)				(.008)
ngen*post*brand				-.034 **				-.059 **				-.021 **
				(.016)				(.015)				(.010)
Active Ingredient Ind.	yes	yes	yes	yes	na	na	na	na	na	na	na	na
Year Indic. or Trend	no	no	no	no	no	no	no	no	no	no	no	no
N	1347	1347	1347	1347	882	882	882	882	646	646	646	646

Note: Retail prices are expressed per daily dose and measured in 1990 DM. Standard errors are in parenthesis. ** and * indicate significance at a 5% and 10% level, respectively. All regressions are estimated using product random effects. Columns 1-4 are estimated using all antiulcerants. Columns 5-12 are estimated using only products with the active ingredient that had generic competitors since 1991. This is the same active ingredient that underwent a significant decline in reference price in 1994. Columns 1-8 consider the effect of insurance change in 1992 on pricing using data from 1986 to 1996. For those columns, the indicator variable post is 1 for 1992 and after. Columns 9-12 consider the impact of additional change in insurance for the active ingredient in question in 1994 using data from 1992 to 1996. For those columns, the indicator variable post is 1 for 1994 and after. Brand is one if product has a brand name.

Appendix table 4--The effect of insurance on pricing for Antiulcerants--Robustness Check

(dependent variable is log retail price)

	RP in 1992 (all products 1986-1996)				RP in 1992 (1986-1996)				RP in 1994 (1992-1996)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
post	-.081 **	-.006	.104 **	-.361 **	-.047	.036	.216 **	-.343 **	.055 *	.157 **	.962 **	.796 **
	(.039)	(.036)	(.049)	(.128)	(.040)	(.037)	(.051)	(.126)	(.030)	(.035)	(.125)	(.145)
brand (yes=1)	.828 **	.849 **	.933 **	.423 **	.581 **	.534	.657 **	.183	.720 **	.708 **	.717 **	.647 **
	(.064)	(.061)	(.065)	(.134)	(.082)	(.079)	(.083)	(.143)	(.071)	(.070)	(.071)	(.127)
brand*post	.120 **	.045	-.042	.412 **	.083 *	.102	-.026	.648 **	-.131 **	-.121 **	-.138 **	.338 *
	(.040)	(.037)	(.045)	(.131)	(.043)	(.038)	(.045)	(.131)	(.032)	(.031)	(.030)	(.205)
Number of generics (ngen)		-.016 **	-.003	-.064 **		-.025 **	-.007 *	-.064 **		-.025 **	-.020 **	-.023 **
		(.001)	(.004)	(.014)		(.002)	(.004)	(.014)		(.005)	(.005)	(.006)
ngen*post			-.012 **	.046 **			-.019 **	.042 **			-.041 **	-.034 **
			(.004)	(.015)			(.004)	(.014)			(.006)	(.007)
ngen*brand				.065 **				.062 **				.005
				(.015)				(.015)				(.008)
ngen*post*brand				-.062 **				-.071 **				-.021 **
				(.015)				(.015)				(.010)
Active Ingredient Ind.	yes	yes	yes	yes	na	na	na	na	na	na	na	na
Time Trend	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	1347	1347	1347	1347	882	882	882	882	646	646	646	646

Note: Retail prices are expressed per daily dose and measured in 1990 DM. Standard errors are in parenthesis. ** and * indicate significance at a 5% and 10% level, respectively. All regressions are estimated using product random effects. Columns 1-4 are estimated using all antiulcerants. Columns 5-12 are estimated using only products with the active ingredient that had generic competitors since 1991. This is the same active ingredient that underwent a significant decline in reference price in 1994. Columns 1-8 consider the effect of insurance change in 1992 on pricing using data from 1986 to 1996. For those columns, the indicator variable post is 1 for 1992 and after. Columns 9-12 consider the impact of additional change in insurance for the active ingredient in question in 1994 using data from 1992 to 1996. For those columns, the indicator variable post is 1 for 1994 and after. Brand is one if product has a brand name.

Appendix Table 5--The effect of insurance on pricing for Antiulcerants with a different comparison group

(dependent variable is log retail price)

	RP in 1992 (all products 1986-1996)				RP in 1992 (1986-1996)				RP in 1994 (1992-1996)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
post	-.261 **	-.152 **	-.164 **	-.652 **	-.247 **	-.049	.094	-.470 **	-.210 **	.167 **	1.148 **	.977 **
	(.049)	(.047)	(.052)	(.129)	(.054)	(.059)	(.074)	(.138)	(.027)	(.061)	(.203)	(.216)
brand (yes=1)	.910 **	.909 **	.898 **	.464 **	.702 **	.617 **	.656 **	.210 **	.725 **	.714 **	.718 **	.646 **
	(.057)	(.056)	(.060)	(.130)	(.081)	(.082)	(.084)	(.143)	(.072)	(.072)	(.072)	(.128)
brand*post	-.005	-.034	-.022	.482 **	-.069 *	.012	-.028	.651 **	-.137 **	-.131 **	-.138 **	.333 *
	(.040)	(.038)	(.044)	(.127)	(.042)	(.042)	(.044)	(.130)	(.032)	(.030)	(.030)	(.205)
Number of generics (ngen)		-.011 **	-.013 **	-.064 **		-.025 **	-.013 **	-.064 **		-.033 **	-.016 **	-.019 **
		(.001)	(.004)	(.014)		(.003)	(.005)	(.014)		(.005)	(.006)	(.007)
ngen*post			.002	.056 **			-.021 **	.035 **			-.051 **	-.044 **
			(.004)	(.014)			(.007)	(.014)			(.010)	(.011)
ngen*brand				.055 **				.059 **				.006
				(.015)				(.015)				(.008)
ngen*post*brand				-.059 **				-.069 **				-.021 **
				(.015)				(.015)				(.010)
Active Ingredient Ind.	yes	yes	yes	yes	na	na	na	na	na	na	na	na
Year Indicators	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	1347	1347	1347	1347	882	882	882	882	646	646	646	646

Note: Retail prices are expressed per daily dose and measured in 1990 DM. Standard errors are in parenthesis. ** and * indicate significance at a 5% and 10% level, respectively. All regressions are estimated using product random effects. Columns 1-4 are estimated using all antiulcerants. Columns 5-12 are estimated using only products with the active ingredient that had generic competitors since 1991. This is the same active ingredient that underwent a significant decline in reference price in 1994. Columns 1-8 consider the effect of insurance change in 1992 on pricing using data from 1986 to 1996. For those columns, the indicator variable post is 1 for 1992 and after. The omitted year indicators in columns 1-8 are 1986 and 1992, so that the effect of insurance is identified with the variation in prices in 1992 relative to 1986. Columns 9-12 consider the impact of additional change in insurance for the active ingredient in question in 1994 using data from 1992 to 1996. For those columns, the indicator variable post is 1 for 1994 and after. The omitted year indicators in columns 9-12 are 1992 and 1994, so that the effect of insurance is identified with the variation in prices in 1994 relative to 1992. Brand is one if product has a brand name.

Appendix Table 6--The effect of insurance on pricing for Oral Antidiabetics--Robustness Check

(dependent variable is log retail price)

	(1)	(2)	(3)	(4)	(5)	(6)
post	-.162 **	-.355 **	-.616 **	-.099 **	-.260 **	-.521 **
	(.015)	(.031)	(.043)	(.017)	(.034)	(.045)
brand (yes=1)	.520 **	.419 **	.860 **	.518 **	.439 **	.865 **
	(.164)	(.161)	(.341)	(.164)	(.161)	(.338)
brand*post	-.287 **	-.167 **	.183 **	-.262 **	-.172 **	.172 **
	(.025)	(.030)	(.050)	(.025)	(.029)	(.049)
Number of generics (ngen)	-.002	-.020 **	-.026 **	.011 **	-.005	-.012 **
	(.003)	(.004)	(.004)	(.004)	(.005)	(.005)
ngen*post		.010 **	.021 **		.008 **	.019 **
		(.001)	(.002)		(.001)	(.002)
ngen*brand			-.010			-.010
			(.012)			(.012)
ngen*post*brand			-.017 **			-.017 **
			(.003)			(.003)
Year Indicators	no	no	no	no	no	no
Time trend	no	no	no	yes	yes	yes
Active Ingredient Indicators	yes	yes	yes	yes	yes	yes

Note: Retail prices are expressed per daily dose and measured in 1990 DM. Standard errors are in parenthesis. ** and * indicate significance at a 5% and 10% level, respectively. All regressions are estimated using product random effects. The indicator variable post is 1 for 1989 and after except for products that obtain RP in 1994. For these products the post indicator is zero through 1993. Brand is one if product has a brand name and zero otherwise. N is 1834.