DOES REGULATION DRIVE OUT COMPETITION IN PHARMACEUTICAL MARKETS?*

PATRICIA M. DANZON and LI-WEI CHAO
University of Pennsylvania

Abstract

Most countries regulate pharmaceutical prices, either directly or indirectly, on the assumption that competition is at best weak in this industry. This paper tests the hypothesis that regulation of manufacturer prices and retail pharmacy margins undermines price competition. We use data from seven countries for 1992 to examine price competition between generic competitors (different manufacturers of the same compound) and therapeutic substitutes (similar compounds) under different regulatory regimes. We find that price competition between generic competitors is significant in unregulated or less regulated markets (United States, United Kingdom, Canada, and Germany) but that regulation undermines generic competition in strict regulatory systems (France, Italy, and Japan). Regulation of retail pharmacy further constrains competition in France, Germany, and Italy. Regulation thus undermines the potential for significant savings on off-patent drugs, which account for a large and growing share of drug expenditures. Evidence of competition between therapeutic substitutes is less conclusive owing to data limitations.

I. Introduction

Most countries regulate manufacturer prices for pharmaceuticals, either directly (France and Italy) or indirectly through controls on insurance reimbursement (Japan) or profits (the United Kingdom). Regulation is often justified by the assumption that price competition is weak for several reasons: patents intentionally limit competition and lead to product differentiation that may be intensified by promotion, insurance makes patients insensitive to prices, and physicians who are primary decision makers may not know product prices and/or may be imperfect agents for patients. Retail pharmacy is also subject to extensive price and entry regulation in countries that regulate manufacturer prices.

The purpose of this paper is to examine the extent of competition under

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alternative regulatory regimes. Prior studies suggest considerable price competition in some markets.[1] However, theory and casual empirical evidence suggest that regulation may undermine competition, although regulation in principle sets a ceiling, but not a floor, on the manufacturer's price. Generic market shares of off-patent products are significantly higher in countries that permit (relatively) free pricing, such as the United States, the United Kingdom, and Germany, than in countries with strict price or reimbursement regulation, such as France, Italy, and Japan. Whether in practice regulation reinforces or undermines competition is an important empirical question that is of interest to research and policy, as different countries (for example, the United States, Japan, France, and the United Kingdom) evaluate possible changes in their regulatory systems.

Optimal competition policy and the extent of competition in practice differ over the life cycle of a new molecule. Originator products are granted patent protection to provide an opportunity to recoup research and development (R&D) expense.[2] Patents bar competition from generic imitators for the life of the patent, which corresponds to roughly the first 10–12 years of life on the market. However, patent-protected drugs may face competition from ''therapeutic substitutes''—drugs with different active ingredients but similar therapeutic effects. After patent expiration, generic imitators can enter the market with minimal R&D expense. The optimal extent of competition while on patent is one element of the broader question of optimal patent structure, which is beyond the scope of this paper. By contrast, there is a strong presumption that price competition between generic substitutes of patent-expired drugs is socially beneficial, assuming that the patent term and structure are designed to yield the socially desired return on R&D.

Generic competition on off-patent drugs offers the potential for significant savings to consumers. Off-patent drugs account for 88 percent of reim-

[1] Henry G. Grabowski & John M. Vernon, Brand Loyalty, Entry, and Price Competition in Pharmaceuticals after the 1984 Drug Act, 35 J. Law & Econ. 331 (1992); W. Duncan Reekie, Medicine Prices and Innovations (1996); and Sara F. Ellison *et al.*, Characteristics of Demand for Pharmaceutical Products: An Examination of Four Cephalosporins, 28 RAND J. Econ. 426 (1997).

[2] Research and development accounts for approximately 30 percent of total costs. See Patricia M. Danzon, Price Regulation in the Pharmaceutical Industry: National vs. Global Interests (1997). If competition resulted in marginal cost pricing, roughly 30–50 percent of total cost would be covered. See Patricia M. Danzon, Price Discrimination for Pharmaceuticals: Welfare Effects in the US and the EU, 4 Int'l J. Econ. Bus. 301 (1997), for use of Ramsey pricing for patented products as a second-best optimal strategy to pay for R&D. For evidence on life-cycle returns to R&D, see Henry G. Grabowski & John M. Vernon, Prospects for Returns to Pharmaceutical R&D under Health Care Reform, in Competitive Strategies in the Pharmaceutical Industry (Robert B. Helms ed. 1996).

bursable packs sold on average for European Union member states,[3] and this off-patent share is expected to grow over the next decade as patents expire on many of the current leading drugs. One suggestion that emerged in the Bangemann Round Table discussions on the European single market for pharmaceuticals is to increase competition in the off-patent sector in order to free up ''headroom'' in public budgets to pay for innovative, patent-protected products.[4] The design of regulatory systems to promote competition in the off-patent sector is an important issue for all governments concerned with obtaining maximum value from health spending.

In this study we use comprehensive data on outpatient drug sales in seven countries (Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States) to estimate the extent of competition between generic and therapeutic substitutes under different regulatory regimes. No previous study has used such comprehensive data or has simultaneously examined generic and therapeutic competition across a range of countries that differ in regulatory regime. W. Duncan Reekie[5] examines prices of successive originator entrants to specific therapeutic categories and finds some evidence of price competition in unregulated markets. Henry Grabowski and John Vernon[6] provide evidence of postpatent competition from generics in the United States after the passage of the Waxman Hatch Act in 1984 and the growth of managed care in the 1990s. Donald Alexander, Joseph Flynn, and Linda Linkins[7] estimate demand elasticities for drugs in seven countries for the period 1980–87, using aggregate market data. However, the estimated elasticity (−2.8) is implausibly large, which implies even larger product-specific elasticities, and may be biased by the limited data available.

We use product-level data on outpatient sales in our seven countries for 1992.[8] We focus on molecules that were available in all seven countries, hereafter called global molecules. We estimate the effect on product price of the number of generic producers of the same molecule and the number of substitute molecules in the same therapeutic category. We also estimate

[3] European Commission, Commission Communication on the Single Market in Pharmaceuticals (1998).

[4] *Id.;* Patricia M. Danzon, Competition in the Off-Patent Sector: The US Experience, 3 Pharma Pricing Rev. 46 (1998).

[5] Reekie, *supra* note 1.

[6] Grabowski & Vernon, *supra* note 2; and Grabowski & Vernon, *supra* note 1.

[7] Donald Alexander, Joseph E. Flynn, & Linda A. Linkins, Estimates of the Demand for Ethical Pharmaceutical Drugs across Countries and Time, 26 Applied Econ. 821 (1994).

[8] The data are from IMS, which is a market research company based in Plymouth Meeting, Pennsylvania.

effects of first-mover advantage, both between molecules in a therapeutic category and between individual products within a molecule. Our primary focus is on product-level competition and prices, but we also report some results for molecule-level prices, defined as the volume-weighted average of prices for all products with the same active ingredient.[9]

We find that generic competition has a significant negative effect on prices in regimes with free pricing (the United States) and those with free pricing subject to moderate constraints (the United Kingdom, Germany, and Canada), whereas for the countries with strict price or reimbursement regulation (France, Italy, and Japan), generic competition is ineffective and may be counterproductive. One plausible explanation is that in regulatory regimes that drive down the originator price over the life cycle, generic equivalents are often licensed co-marketers or minor ''new'' versions of old molecules introduced by manufacturers as a strategy to obtain a higher regulated price. By contrast, in countries with free pricing, generic entrants must compete on price to gain market share. For therapeutic substitutes, our results are less conclusive, possibly as a consequence of endogeneity and omitted variable bias.

The paper is structured as follows. Section II describes the demand for drugs and expected effects of regulation. Section III outlines the reduced-form model of price determination. Section IV describes the data and methods. Section V reports regression analysis of product prices and tests for significant differences between countries. Section VI decomposes the mean price differentials into mean characteristics and parameter effects. Section VII concludes.

II. The Demand for Drugs: Theory

The demand for prescription drugs depends on the interaction between consumers' demand for medical care and the choices of physicians who prescribe and pharmacists who dispense drugs. Regulation and competition define the incentives and constraints on these choices, along with the consumers' health insurance coverage. For nonprescription, over-the-counter (OTC) drugs, the patient is the primary decision maker, but regulation of retail pharmacies may affect the prices and choice available. Here we summarize the pertinent features of insurance and regulatory regimes as of 1992.[10]

[9] For more detailed molecule-level analysis, see Patricia M. Danzon & Li-Wei Chao, Cross-National Price Differences for Pharmaceuticals: How Large and Why? 19 J. Health Econ. 159 (2000).

[10] For a more detailed description of the insurance and regulatory systems, see Danzon, Price Regulation, *supra* note 2.

A. Consumers and Insurance

In 1992, insurance coverage of drugs through social insurance programs was extensive in all countries in our sample except the United States, where patients paid roughly 50 percent of outpatient drug expense directly out of pocket. Although some countries' social insurance systems nominally require significant patient co-payment, as either a percentage of the price (France, Italy, and Japan) or a fixed payment per script (the United Kingdom and Germany), these nominal co-payments overstate the average marginal co-insurance rate because of exemptions for high-use groups (the elderly and welfare recipients), private supplementary insurance that covers co-payments under the public scheme (France), and stop-loss limits on out-of-pocket payments (Japan). Moreover, all countries except the United States had low or zero co-payments on physician visits, which could be a significant component of the full price of obtaining prescription drugs.

There are two exceptions to this extensive insurance coverage. First, in 1989 Germany introduced a reference price system (see below), primarily for off-patent, multisource drugs, that requires patients to pay any excess of the manufacturer's price over the reimbursement or reference price. This reference price system with 100 percent marginal co-payment accounted for 40 percent of expenditures in 1992.[11] Second, in the United States, many people who were insured for physician and hospital services had no coverage for outpatient drugs and, hence, faced the full price. In addition, many of those with coverage had plans with generic substitution programs, which set a maximum allowable charge (MAC) for generically equivalent drugs and require the patient to pay any excess of the actual price over the MAC, as in Germany's reference price system.

Given this extensive insurance coverage, consumer demand is expected to be price inelastic, with no significant difference across countries, with the possible exception of the United States and multisource drugs in Germany.

B. Physician Agents

A physician's prescription is required to obtain prescription drugs. If physicians are imperfect agents for patients, their prescribing choices may reflect their own direct financial or nonfinancial incentives due to insurers' reimbursement and cost control strategies, in addition to concern for the patients' health or wealth.[12] However, as of 1992, physicians in most countries

[11] Verband Forschender Arzneimittelhersteller (VFA), Statistics '97: The Pharmaceutical Industry in Germany (1997).

[12] For a model of imperfect physician agency and empirical evidence on the effects of Germany's reference price system and drug budgets, see Patricia M. Danzon & Hong Liu, Reference Pricing and Physician Drug Budgets: The German Experience in Controlling Phar-

in our sample were not at financial risk for costs or profit from the drugs that they prescribed and, hence, had no personal incentive to know drug prices or be price sensitive.

The main exception is Japan, where physicians dispense the drugs that they prescribe and may capture the margin (M) between the reimbursement price (R) and the acquisition price (P). Physician demand in Japan is expected to be sensitive to the profit margin, $dQ/dM > 0$, where $M = R - P$. Our data report P but not M or R. The prediction with respect to P is ambiguous, since in cross section P is likely to be positively correlated with the unobserved R due to the regulatory system (see below).

A second, more limited exception to the conclusion of no incentives for price sensitivity by physicians is the United Kingdom. Since 1990, a minority of general practitioners (fund-holding GPs) received a prescribing budget. Fund holders who underspent their drug budget could reinvest the savings in their practice, but they were not at risk for budget overruns.[13] Nonfund-holding GPs had ''indicative'' target drug budgets but with no financial penalties for overruns. Darrin Baines, Keith Tolley, and David Whynes[14] find that the main effect of fund holding was to encourage generic substitution.[15]

In conclusion, although differences in patient co-payments and physician incentives could in theory contribute to cross-country differences in demand elasticities, as of 1992 the co-payment and physician differences were small, with exceptions noted for the United States, the United Kingdom, and Germany, compared to differences in pharmacy and price regulation described next.

C. Pharmacy Regulation and Generic Substitution

Given the physician's choice of molecule, pharmacists are authorized in some countries to substitute between generically equivalent products to fill the prescription. In the United States by the 1990s all states had repealed

maceutical Expenditures (Working paper, Univ. Pennsylvania, Wharton Sch. 1998). Alan L. Hillman *et al.*, Financial Incentives and Drug Spending in Managed Care, 18 Health Affairs 189 (1999), shows the interaction between patient and physician incentives in U.S. managed care.

[13] Germany adopted a national spending limit for drugs with physicians at risk for overruns in 1993. In the United States, some managed care plans capitate physicians for drug costs, but this was relatively uncommon in 1992.

[14] Darrin L. Baines, Keith H. Tolley, & David K. Whynes, Prescribing Budgets and Fundholding in General Practice (1997).

[15] In the United Kingdom, roughly 10 percent of (mostly rural) physicians directly dispense drugs and can profit from the reimbursement–acquisition cost margin, as in Japan, and hence are expected to be price sensitive, particularly for generics.

antisubstitution laws and authorized pharmacists to substitute generic equivalents unless the physician explicitly writes ''dispense as written.'' Managed care plans and Medicaid encourage generic substitution for off-patent drugs by paying a maximum allowable charge (MAC, or reference price) for generically equivalent products. Since the pharmacist captures the difference between the MAC and the manufacturer price (net of the wholesale margin), generic substitution programs are predicted to generate high cross-price demand elasticities for generically equivalent products.

Similarly, pharmacists in the United Kingdom may substitute a generic if the prescription is generically written (that is, the molecule is described by chemical name rather than brand name), which occurs in over 60 percent of GP prescriptions. The pharmacist retains the margin between the National Health Service (NHS) reimbursement price (the NHS Drug Tariff) and the acquisition cost of the product dispensed, as in U.S. generic substitution programs. Generic substitution programs exist in most Canadian provinces, with differences in detail across provinces. In Germany, pharmacists are permitted to substitute between generically equivalent products where the script is generically written, but this occurred in less than 5 percent of scripts.[16] German generics are typically branded and compete by promoting a brand image, in contrast to the United States, where many generics are unbranded and competition focuses primarily on price. In France, Italy, and many other European countries, generic substitution by pharmacists is not permitted.

Retail pharmacy in Germany, France, Italy, and many other countries is subject to entry and price regulations that impede competition in both retail and manufacturer-level prices. Pharmacists are paid a regulated dispensing margin based on the product price. Although the percentage margin may be digressive (the percentage varies inversely with the product price), the absolute margin usually increases with drug price, which undermines incentives to substitute cheaper products, even if authorized. Although OTC prices are not regulated, OTCs are subject to retail price maintenance in most countries, and retail margins are regulated. France, Italy, and Germany require unit pack dispensing; that is, pharmacists are not permitted to split large packs as they can in the less regulated markets of the United States, the United Kingdom, and Canada. Unit pack dispensing reduces the potential for volume discounts from manufacturers and facilitates price monitoring and, hence, is likely to obstruct chiseling on the list price. Retail price competition between pharmacies is further discouraged by restrictions on the

[16] Oliver Schoffski, Consequences of Implementing a Drug Budget for Office-Based Physicians in Germany, 10(2) PharmacoEconomics 37 (1996).

number of pharmacies, legal requirements that each pharmacy be owned by a licensed pharmacist, restrictions on branch pharmacies, and so on.[17]

Differences in pharmacy regulation and generic substitution programs are predicted to generate significant cross-national differences in the price sensitivity of demand facing manufacturers of generically equivalent products. Specifically, cross-price demand elasticities between generically equivalent products are expected to be high in the United States, the United Kingdom, and Canada, where substitution is permitted and profitable for pharmacists. Conversely, regulation and barriers to price competition between pharmacists are expected to result in low cross-price elasticities between generics in France, Italy, and possibly Germany; however, in Germany this is mitigated by the incentives for patients and physicians under reference pricing (see below).

D. Price and Reimbursement Regulation

Although each country's system for regulating manufacturer prices for drugs is unique, countries can be categorized into those that regulate prices or reimbursement of individual drugs (France, Italy, and Japan), those that do not (the United States), and a mixed group (the United Kingdom, Germany, and Canada).

In the first group, France and Italy require regulatory approval of the manufacturer's launch price before a drug can be reimbursed by the social insurance scheme. Postlaunch price increases are usually disallowed, and decreases may be mandated. Japan also sets the initial reimbursement price at launch. However, manufacturers compete by cutting price below the reimbursement price to increase the profit margin offered to dispensing physicians and induce switching to their drug. Every 2 years, the government revises the reimbursement price downward based on a survey of actual manufacturer prices plus an allowed margin (15 percent in 1992). The Canadian Medicines Review Board monitors prices to assure that launch prices are ''reasonable.'' Prices for innovative products cannot exceed the median of prices in seven other countries; for noninnovative products, the benchmark is prices of established products. Postlaunch price increases are limited to the rate of inflation.

These regulatory systems have two common characteristics that are expected to affect competition. First, regulation forces down the real product price over the drug's life cycle in France, Italy, and Japan. In France and

[17] For discussion of barriers to competition in retail pharmacy, see W. Duncan Reekie, Cartels, Spontaneous Price Discrimination and International Pharmacy Retailing, 4 Int'l J. Econ. Bus. 279 (1997); F. M. Scherer, How US Antitrust Can Go Astray: The Brand Name Prescription Drug Litigation, 4 Int'l J. Econ. Bus. 239 (1997).

Italy, this reflects denial of inflation adjustments; in Japan, the downward spiral results from superimposing regulation on a market with competition for physician demand.[18] The lower the originator product's price when the patent expires, the lower the potential profit margin for a generic competitor pursuing a price competition strategy, and hence the less attractive is the market for competitive generic entry. Moreover, the demand facing a potential generic entrant is expected to be price inelastic, owing to regulated pharmacy margins and absence of generic substitution programs.

Second, in all four of these countries (France, Italy, Japan, and Canada) the price of established products is used as a regulatory benchmark for setting prices for new products. If the relation were a simple average, this price-setting mechanism would yield

$$P^0_{n+1jk} = \frac{1}{N_j}\frac{1}{N_k}\sum_{i=1}^{N_j}\sum_{j=1}^{N_k} P_{ijk} = \frac{1}{N_j}\frac{1}{N_k}\sum_{i=1}^{N_j}\sum_{j=1}^{N_k} P^0_{ijk}e^{\rho t}_{ijk},$$

where P^0_{n+1jk} is the launch price of the $(n + 1)$th product in molecule j in therapeutic category k, t_{ijk} is the number of years product ijk has been on the market, and ρ is the real rate of price change since launch, which could be negative. In fact the relationship is only approximate: some comparator products are more relevant than others; the new product may obtain a markup for improved efficacy or usefulness; and the regulated launch price may be higher if a firm makes a significant local investment, co-markets with a domestic firm, or has other influence. Nevertheless, this approach to regulation implies that if real prices of established products decline with time on the market, launch prices of successive entrants will be inversely related to the number of competitor products already on the market, ceteris paribus. This effect is expected to be less negative in Canada, which permits inflation adjustments for established products, than in France, Italy, and Japan, which do not permit inflation adjustments. The conventional wisdom is that regulatory systems in France, Italy, and Japan, by driving down prices over the life cycle, create incentives for local manufacturers to introduce a stream of minor new products in order to obtain a higher price, and that this has undermined their competitiveness in truly innovative R&D.[19] If true, this implies

[18] The inflation-adjusted Divisia index for drugs for 1981–92 in Japan is −6.8 percent per year, −4.3 for Italy, and .25 for France. See Patricia M. Danzon & Jeong D. Kim, Price Indexes for Pharmaceuticals: How Accurate Are International Comparisons? (Working paper, Univ. Pennsylvania, Wharton Sch. 1996).

[19] These three countries have lagged other, less regulated countries in the development of innovative new drugs although not in the total number of new drugs, including minor extensions of existing molecules. See Etienne Barral, Twenty Years of Pharmaceutical Research Results throughout the World (1975–1994) (1995); Lacy Glenn Thomas II, Industrial Policy and International Competitiveness in the Pharmaceutical Industry, in Competitive Strategies in the Pharmaceutical Industry, *supra* note 2, at 107.

that a new product typically receives a somewhat higher price than established products, despite the downward pressure that results from tying prices for new products to prices for existing products.

In contrast to these strictly regulated countries, the United Kingdom and Germany permit relatively free pricing. In the United Kingdom a manufacturer can set the price of a new patented product at launch, subject to a constraint on its overall rate of return on capital in the United Kingdom for all products sold to the NHS, typically 17–21 percent. Price increases require approval. After patent expiration and generic entry, the Drug Tariff defines a maximum reimbursement (reference) price for generics based on an audit of pharmacies' actual acquisition prices. Generic manufacturers compete by discounting prices, to increase the pharmacist's margin between reimbursement and acquisition price. The Drug Tariff price is periodically revised downward on the basis of actual supply prices but with a lag. For example, the April 1992 Pharmacist Discount Enquiry showed average discounts on generic medicines of 47.7 percent (of which roughly 12.5 percent is the wholesale margin). Following deep reductions in NHS prices, the April 1993 survey found average discounts of only 26 percent.[20] These discounts are not fully reflected in the IMS data; hence, our estimates for the United Kingdom may significantly overestimate actual manufacturer prices, particularly for multisource products.

In Germany, manufacturer prices were unregulated until 1989, when a reference price system was introduced. A reference price system classifies drugs into groups that are considered close substitutes and sets a single reference price for each group as the maximum reimbursement for all drugs in the group. Phase 1 applied to generically equivalent products in multisource molecules; phases 2 and 3 included therapeutically similar molecules. Manufacturer prices remain unregulated; however, since the patient must pay any excess of the manufacturer's price over the reference price, demand is expected to be highly elastic above the reference price. Moreover, German physicians are required to explain to the patient why they need a drug priced above the reference price. Prescribing a relatively high-priced product may thus entail an unreimbursed time cost for German physicians, which is expected to make physicians price sensitive in their choices between generically equivalent drugs.[21] For non-reference-priced products, prices remained unregulated as of 1992.

[20] United Kingdom Department of Health, Pharmacist Discount Enquiry, April 1992 and April 1993. The pharmacists' reimbursement is the NHS Drug Tariff net of a ''clawback'' (roughly 7 percent) that is intended to reflect the average discount on generic and parallel imported products.

[21] Brand product prices generally drop to the reference price; see REMIT Consultants, Cost Containment in the European Pharmaceutical Market: New Approaches (1991). Danzon & Liu, *supra* note 12, finds that German reference pricing reduced the weighted average molecule price and accelerated the rate of price decline.

In the United States, manufacturer prices are unregulated. Since the mid-1980s, managed care has changed the nature of competition. Health maintenance organizations (HMOs) and other pharmacy benefit managers (PBMs) create formularies of ''preferred'' drugs that physicians and patients are encouraged to use. The ability to shift demand toward one or two preferred products within a group of therapeutic substitutes has increased demand elasticity in the managed care sector, which has enabled PBMs to negotiate discounts from list prices for branded products. Since 1990 Medicaid and other public purchasers require discounts off list prices equal to 15 percent or the ''best price'' given to any private purchaser.[22] Because these managed care and Medicaid discounts are confidential and rebated directly to the purchaser, they cannot be calculated from the IMS data used here. Our U.S. price data are therefore upward biased for net-of-discount transactions prices, and our estimates of price elasticities may be downward biased in absolute value, particularly for therapeutic competition since deep discounting tends to be concentrated in crowded therapeutic categories.

III. A Model of Drug Pricing

A manufacturer's optimal strategy in pricing pharmaceuticals in theory considers intertemporal and cross-country demand dependence. Since we have only a single cross section of price data, we ignore life-cycle and cross-country pricing concerns and assume a single-period, single-location model. In the absence of regulation, markets are assumed to be imperfectly competitive, because of product differentiation between therapeutic substitutes and because of weak incentives for patients and/or physicians to be informed or sensitive to prices owing to insurance, with the exceptions for generic substitutes noted above. Since price regulation sets a ceiling but not a floor, we apply the same model to all countries. Different regulatory regimes then imply hypotheses about differences in parameter values to be tested empirically.

The demand for product i is assumed to depend on a vector of quality attributes, Z_i, and on the prices charged by competitors. Not all competitors are equally close substitutes. Generic substitutes, which include licensed, co-marketed products as well as postpatent imitators, have the same active ingredient and are very close substitutes. Therapeutic substitutes are chemi-

[22] Between first-quarter 1991 and 1993, the median best-price discount declined from 24 percent to 14 percent for HMOs, from 28 percent to 15 percent for group purchasing organizations; see U.S. General Accounting Office (GAO), Medicaid: Changes in Best Price for Outpatient Drugs Purchased by HMOs and Hospitals (GAO/HEHS-94-194FS 1994). Unweighted average best-price discounts declined from 42 percent in first-quarter 1991 to 33.4 percent in fourth-quarter 1992; see U.S. Congressional Budget Office, How the Medicaid Rebate on Prescription Drugs Affects Pricing in the Pharmaceutical Industry (1996).

cally distinct compounds that have similar therapeutic effects for at least some patients. In the short run, the number and characteristics of products in the market are taken as given.

The inverse demand for product i in molecule j in therapeutic category k is

$$P_{ijk} = P[Q_{ijk}; Z_{ijk}, P_{xj}(N_j), P_{xk}(M_k, N_k)],$$

where P_{ijk} is the price per unit of product i, Q_{ijk} is the number of units, Z_{ijk} is a vector of quality attributes, P_{xj} is the mean price of generic competitors, P_{xk} is the mean price of therapeutic competitors, N_j is the number of generic competitors in molecule j, M_k is the number of molecules in therapeutic category k, and N_k is the mean number of competitors per molecule for the $M - 1$ other molecules in category k, excluding molecule j.

Each firm is assumed to follow a Bertrand strategy in setting the price for its product, taking the prices of competing products as given. Equilibrium prices are predicted to be inversely related to the number of generic competitors, the number of therapeutic substitute molecules, and the number of products per therapeutic substitute molecule: $dP_{ijk}/dN_j < 0$, $dP_{ijk}/dM_k < 0$, and $dP_{ijk}/dN_k < 0$.[23] If the cross-price demand elasticity is more negative between generic competitors (same molecule) than between therapeutic substitutes (different molecules), then price elasticity is predicted to be greater with respect to the number of generic competitors than for therapeutic substitutes:

$$|dP_{ijk}/dN_j| > |dP_{ijk}/dM_k|.$$

The negative effect of therapeutic substitutes is expected to be greater, the greater the number of products per molecule.

This model implies a reduced-form estimating equation of the form

$$P_{ijk} = \beta_1 Z_{ijk} + \beta_2 N_j + \beta_3 M_k + \beta_4 N_k + u_{ijk}. \quad (1)$$

This model has three potentially significant limitations, due to lack of data. First, as noted earlier, the U.S. data do not reflect discounts to managed care and Medicaid, and the U.K. data do not reflect all discounts to pharmacists on generics. Second, we lack data on manufacturers' promotional investments that may influence market demand, including promotion to physicians and, for some drugs, direct-to-consumer advertising. Promotional investments are expected to be greater for on-patent products, where any demand expansion accrues primarily to the firm that undertakes the investment, than for off-patent products, where any increased demand for the

[23] The same predicted relation between price and number of competitors would also follow from a Cournot strategy.

molecule may be largely captured by other generic competitors.[24] However, even for on-patent drugs, one firm's promotion may increase awareness of the product class, with demand-increasing spillover effects to other drugs in the same class. In that case, demand is positively correlated with the number of molecules in the class due to unobserved promotion, which may bias upward our estimates of dP_{ijk}/dM_k. This demand-shifting effect of promotion is expected to be associated with both higher price and volume in unregulated markets, whereas in price-regulated markets, promotion is more likely to affect volume.[25] We return to this below.

Third, although a full, multiperiod model would treat entry and number of competitors as endogenously related to expected profits, with our single-year, cross-sectional data we are forced to treat the number of competitors as exogenous. This could result in upward-biased estimates for dP_{ijk}/dN_j and dP_{ijk}/dM_k. The decision to develop therapeutic substitutes (M_k) depends on price expectations in years t through $t - 12$ or earlier for older molecules.[26] Thus, if prior price expectations are positively correlated with current prices, the number of therapeutic substitutes may be positively related to actual prices, leading to upward-biased estimates of dP_{ijk}/dM_k. Similarly, generic entry decisions are presumably based on expected profits. If expectations are unbiased on average, then current prices may be positively correlated with prior expected profits, in which case our estimates of dP_{ijk}/dN_j may be upward biased.

IV. Data, Variable Definitions, and Methods

A. Sample

The data used here are from IMS data on all drug sales through retail pharmacies between October 1, 1991, and September 30, 1992. Prices are at the manufacturer level. As noted, the U.S. price data may be upward biased because of the omission of discounts paid directly to managed care or Medicaid; these IMS data also exclude sales through mail order, supermarkets, and HMOs. The U.K. prices may similarly be biased because of the

[24] Consistent with this, originator firms reduce promotional investment before patent expiration; see Richard E. Caves, Michael D. Whinston, & Mark A. Hurwitz, Patent Expiration, Entry, and Competition in the U.S. Pharmaceutical Industry, Brookings Papers on Economic Activity: Microeconomics 1991, at 1.

[25] For example, the French regulatory system sometimes imposes an ''envelope globale,'' which requires a reduction in price if volume exceeds a target level, particularly for products with significant budget impact.

[26] The mean lag from initiating R&D to regulatory approval was roughly 12 years for drugs launched in the 1980s. See Joseph DiMasi *et al.,* The Cost of Innovation in the Pharmaceutical Industry, 10 J. Health Econ. 107 (1991).

omission of discounts to pharmacists. Except where noted, we restrict the sample to single-molecule ''global'' products, that is, products that contain a single active ingredient (molecule) and are available in all seven countries.[27] A given molecule may have multiple products (defined by molecule, manufacturer, and IMS product name)—for example, originator brand, licensees, parallel imports, and generics—and each product may have multiple packs, defined by strength, presentation forms, and pack sizes. Although the sample of molecules is uniform across countries, the number of products per molecule, manufacturers, and packs differ across countries. The unit of analysis here is the product, aggregated over packs for each product.[28] After deleting observations with missing data, there are 171 global molecules with a total of 5,690 products in the sample.[29]

B. Variable Definitions

Price. For each pack, IMS reports the price per ''standard unit,'' which is a rough proxy for a dose, defined as one tablet, one capsule, 10 milliliters of a liquid, and so on. We define the average price per standard unit for each product as the volume-weighted average over all forms and packs in the product. The price distribution is approximately lognormal. For the regression analysis we therefore use the log transform of price and of all explanatory variables where proportional effects are expected. Foreign currency values are converted to U.S. dollars using 1992 exchange rates.

Quality. We control for several ''quality'' characteristics that may affect the product's efficacy or convenience and, hence, its price. Molecule Age, measured as (log) months from September 1992 (the last observation month) to the launch date of the first product in the molecule, is an inverse indicator of therapeutic effectiveness, assuming that more recent compounds are generally more effective. Molecule Age is the same for all products in a molecule but is country specific. Molecule Age may also reflect life-cycle pricing strategies in unregulated markets and age-related regulatory or cohort effects. The individual product's launch date relative to the molecule age is also included to measure competitive (dis)advantage relative to the originator product (see below).

[27] Multiple-molecule (combination) products are excluded because the relative mix of different molecules may differ, which reduces comparability across countries and makes ambiguous the definition of such variables as strength or number of generics competitors.

[28] We follow IMS (and the manufacturer) in defining a new dosage form—for example, a delayed release tablet—as a new product rather than a new formulation of an old product if it has a different product name. Thus Procardia XL is a product distinct from Procardia.

[29] We performed influence diagnostics but retained the small number of influential observations because these did not appear to result from data error. Conclusions from the regression analysis are robust to omitting these observations.

Strength is the mean grams of active ingredient per standard unit, averaged over all packs within the product. The expected sign is positive, if the within-molecule strength effect (expected therapeutic effect per unit should increase with grams of active ingredient) dominates the between-molecule effect (the most potent molecules may have weak strength per pill but command high prices). The number of different formulations (Form Codes) of the product is included as a measure of the choice and convenience available to patients. The coefficient is expected to be positive, assuming that manufacturers launch new forms only where the expected increase in price is sufficient to cover the fixed costs of developing a new form. We also include a vector of 13 binary indicators of anatomical therapeutic category (ATC)—for example, cardiovascular drugs (the omitted category), dermatologics, and so on—which denote the product's primary medical indication and also control for differences in insurance coverage that is greater for ''medically necessary'' drugs than for ''comfort'' drugs in some countries.

Competition. Our measures of competition distinguish between generic and therapeutic substitutes. Generic Competitors is the number of generically equivalent products in the molecule, including originator, licensed, and parallel import products, as well as postpatent generic imitators.[30] The data unfortunately do not distinguish between these categories of generically equivalent products.

The expected effect of generic imitators on price is negative in markets where manufacturer prices are unregulated and, in particular, where retail pharmacy is unregulated and generic substitution is permitted (the United States, the United Kingdom, and Canada); a negative effect is also expected in Germany owing to reference pricing. Price competition is expected to be less intense or nonexistent between originator and licensee generic equivalents. An originator firm may voluntarily license a local firm to co-market or co-promote a product in markets where the originator firm lacks a strong reputation or sales force. Firms that co-market or co-promote have aligned incentives to avoid price competition and, in regulated markets, usually receive the same regulated price. Moreover, in regulated markets multinational originator firms sometimes allegedly grant a license to a local firm in return for a higher regulated price. Such ''involuntary'' licensure associated with a higher price is an additional factor leading to a less negative predicted effect of Generic Competitors on price in regulated markets than unregulated markets.

[30] The results are invariant to measuring generic competitors as the number of products or number of manufacturers, because most manufacturers produce only one product per molecule. Parallel imports occur when wholesalers trans-ship the originator product from a low-price country to a higher price country in the European Union. See Danzon, Price Discrimination, *supra* note 2.

Therapeutic Substitute Molecules is the number of molecules in the three-digit therapeutic category (ATC), including both global and nonglobal molecules. This ATC measure of therapeutic substitutes is the best available but is subject to measurement error to the extent that substitutability differs between molecules in a therapeutic category and drugs in other categories may also be substitutes. To test the hypothesis that the cross-price elasticity between molecules increases as the number of producers per molecule increases, we also include the mean number of Products per Therapeutic Substitute Molecule.

Several previous studies have found evidence of a first-mover advantage in pharmaceuticals and in other industries. We distinguish within-molecule and between-molecule effects. Generic Entry Lag is the (log) number of months between the product's own launch date and the launch date of the first product in the molecule (plus one). This ranges from one for the originator product to large positive values for late entrants.[31] The expected sign is negative, under the hypothesis that the originator product has a first-mover advantage relative to later generic producers of the same molecule, which offer little or no therapeutic advantage. Therapeutic Substitute Molecule Entry Lag is (log) months from the launch of this molecule to the launch of the first molecule in the therapeutic category. The sign could be negative or positive, depending on whether first-mover advantage of the pioneer molecule in a class dominates or is dominated by superior efficacy of later molecules.

Pack Size (average number of units per pack) is an additional indicator of competition. Price is expected to be inversely related to pack size in countries with competitive retail pharmacy (the United States, the United Kingdom, and Canada), where manufacturers, particularly generics, compete by offering volume discounts to pharmacists on large packs. In countries that require unit dispensing (France, Germany, and Italy), the range of pack sizes is expected to be smaller and the price–pack-size relationship is expected to be less negative.

V. Empirical Results

A. Differences in Means

Table 1 reports product-level means for all variables, by country, and *t*-tests for significant difference between each country's mean and the U.S. mean. Since the unit of observation in Table 1 is the product, each molecule

[31] We lack data on patent expiry dates, so we cannot measure time since patent expiry as used in previous studies.

implicitly receives a weight equal to the number of products in the molecule. Table 2 reports molecule-level means, where each molecule receives a weight of one and the value for each molecule is a weighted average over products in that molecule. The molecule means may be more intuitively meaningful for variables that do not vary across products in the molecule.

The mean price per product does not differ significantly across countries (Table 1), as a result of the large number of generics in the U.S. sample, whereas the mean price per molecule is significantly lower in France, Italy, and the United Kingdom than in the United States (Table 2), consistent with the estimates of weighted price indexes per molecule, which show substantial differences between countries.[32] Mean Molecule Age (Table 2) is higher in all countries than in the United States, with significant difference in Germany, France, Italy, and the United Kingdom. This is consistent with other evidence that the 1962 Amendments to the U.S. Food, Drug and Cosmetics Act delayed the launch of new molecules in the United States relative to other countries.[33] The high mean age for all countries (20 years or more) reflects partly the influence of a few very old molecules and partly the fact that global diffusion takes time; hence a sample of global molecules cannot include the newest molecules.

The mean number of Generic Competitors per molecule, including licensees and generic imitators, is significantly higher in the United States than in all other countries (see Table 2): 11.1 in the United States, compared to 6.6 in Germany, 4.5 in Japan, 3.3 in Canada, 3.0 in Italy, 2.4 in France, and 2.3 in the United Kingdom. These relatively large numbers reflect both the high mean age of the sample and the fact that global molecules tend to be the most valuable and hence attract the most products per molecule. Consistent with this, the mean number of Products per Therapeutic Substitute Molecule, which includes products in nonglobal molecules as well as other global molecules in the therapeutic category, is consistently lower than the mean Generic Competitors for the global molecules. However, the pattern across countries is the same, with the United States having more than twice as many Products per Therapeutic Substitute Molecule as

[32] Patricia M. Danzon & Jeong D. Kim, International Price Comparisons for Pharmaceuticals: Measurement and Policy Issues, 14 PharmacoEconomics 115 (1998); Danzon & Chao, *supra* note 9.

[33] David Dranove & David Meltzer, Do Important Drugs Reach the Market Sooner? 25 RAND J. Econ. 402 (1994), estimates that the average time from a drug's first worldwide patent application to its approval by the U.S. Food and Drug Administration rose from 3.5 years in the 1950s to almost 6 years in the 1960s and 14 years in the mid-1980s. William M. Wardell & Louis Lasagna, Regulation and Drug Development (1975), reports that the United States lagged behind every major European country in new drug introductions. For molecules launched since 1980 (Molecule Age less than or equal to 12, present in five of the seven countries) we find no evidence of U.S. regulatory lag.

TABLE 1

VARIABLE MEANS, STANDARD DEVIATIONS, AND *t*-STATISTICS FOR DIFFERENCES RELATIVE TO THE U.S.
UNIT OF OBSERVATION: PRODUCTS IN GLOBAL MOLECULES, RETAIL PHARMACY — 1992

Variable	U.S.	Canada	Germany	France	Italy	Japan	U.K.
Price per unit:							
Mean	.592	.728	.547	.472	.581	.652	.645
SD	3.028	3.026	1.371	1.607	.920	1.802	2.120
t		.939	.556	1.130	.133	.634	.419
Quality:							
Strength:							
Mean	.216	.173	.221	.269	.325	.183	.225
SD	.664	.223	.436	.526	.895	.443	.872
t		2.392	.277	1.771	2.566	1.510	.186
Age:							
Mean	305.264	304.659	338.524	307.353	281.458	295.552	318.860
SD	128.225	152.123	185.374	148.537	176.061	122.332	143.195
t		.086	5.323	.263	2.865	1.839	1.755
Form Codes:							
Mean	2.680	2.436	2.636	2.084	2.129	2.054	2.619
SD	1.718	1.513	1.736	1.426	1.232	1.317	1.723
t		3.260	.681	7.361	8.218	10.188	.648
Competition:							
Pack Size:							
Mean	193.939	231.018	60.774	37.052	36.795	528.671	102.175
SD	190.393	236.046	52.801	44.536	62.236	505.419	125.533
t		3.406	28.729	32.080	30.486	17.949	11.996

Generic Competitors:							
Mean	25.518	6.589	15.573	4.768	6.497	9.069	4.514
SD	13.310	5.491	10.213	4.211	5.379	6.090	3.319
t		49.407	23.105	56.116	49.218	43.856	60.496
Generic Entry Lag:							
Mean	207.942	129.200	184.135	111.570	85.431	112.714	100.584
SD	133.364	141.553	176.566	148.563	147.282	112.207	134.804
t		11.724	3.918	12.063	17.052	18.845	14.492
Therapeutic Substitute Molecules:							
Mean	10.552	8.345	15.238	11.716	15.947	15.866	9.799
SD	5.605	4.767	10.594	7.217	12.191	11.426	6.916
t		9.240	13.770	3.056	9.750	12.372	2.038
Products per Therapeutic Substitute Molecule:							
Mean	6.960	2.315	3.380	1.606	2.235	2.770	1.906
SD	3.776	1.277	2.663	.633	1.044	1.150	1.160
t		45.572	30.529	58.168	48.204	43.720	48.512
Therapeutic Substitute Molecule Entry Lag:							
Mean	124.075	113.277	245.049	159.756	169.384	131.737	131.145
SD	124.851	133.732	235.763	174.964	129.529	126.489	137.006
t		1.705	15.972	3.899	7.086	1.429	.952
N	1,906	560	1,130	405	513	777	399

TABLE 2

VARIABLE MEANS, STANDARD DEVIATIONS, AND *t*-STATISTICS FOR DIFFERENCES RELATIVE TO THE U.S.
UNIT OF OBSERVATION: GLOBAL MOLECULES, RETAIL PHARMACY—1992

Variable	U.S.	Canada	Germany	France	Italy	Japan	U.K.
Price per unit:							
Mean	.903	.857	.746	.396	.504	.672	.485
SD	1.816	2.349	1.314	.678	.920	1.598	1.033
t		.201	.912	3.419	2.562	1.248	2.612
Quality:							
Strength:							
Mean	.190	.171	.203	.241	.290	.142	.158
SD	.367	.288	.378	.633	1.024	.346	.336
t		.536	.315	.904	1.197	1.242	.852
Age:							
Mean	240.994	259.620	312.380	268.135	282.082	257.497	283.409
SD	143.717	144.527	191.182	138.625	157.405	136.463	142.418
t		1.195	3.903	1.777	2.521	1.089	2.741
Form Codes:							
Mean	3.830	3.135	3.895	2.579	2.643	3.012	3.392
SD	2.473	1.863	2.228	1.669	1.552	1.652	2.001
t		2.939	.253	5.484	5.317	3.599	1.803
Competition:							
Pack Size:							
Mean	118.715	168.008	63.222	39.490	37.784	397.973	93.942
SD	82.804	156.517	43.290	52.154	59.431	353.162	108.050
t		3.640	7.766	10.587	10.383	10.067	2.380

Generic Competitors:							
Mean	11.146	3.275	6.608	2.368	3.000	4.544	2.333
SD	12.694	3.304	7.720	2.391	3.249	4.548	2.262
t		7.847	3.994	8.886	8.130	6.403	8.938
Generic Entry Lag:							
Mean	116.588	66.863	113.602	51.640	45.704	63.726	44.369
SD	119.734	83.723	133.654	82.764	89.177	79.005	76.211
t		4.451	.218	5.835	6.209	4.819	6.654
Therapeutic Substitute Molecules:							
Mean	7.286	6.014	10.443	9.214	9.457	9.586	6.800
SD	4.976	4.241	7.573	6.510	7.619	8.044	5.216
t		1.627	2.915	1.969	1.997	2.034	.564
Products per Therapeutic Substitute Molecule:							
Mean	6.389	2.225	3.023	1.520	2.111	2.578	1.651
SD	4.317	1.391	2.540	.613	1.044	1.191	.978
t		12.007	8.788	14.604	12.595	11.129	14.000
Therapeutic Substitute Molecule Entry Lag:							
Mean	163.608	139.760	230.099	179.532	168.123	154.965	146.187
SD	151.896	143.927	232.834	163.241	136.214	133.571	132.541
t		1.490	3.128	.934	.289	.559	1.130

NOTE.—$N = 171$.

all other countries. By contrast, the mean of Therapeutic Substitute Molecules (molecules in the ATC) is higher in Germany, France, Italy, and Japan than in the United States. This suggests that the much larger number of generic competitors in the United States than in other countries is not attributable simply to the larger U.S. market size. The large number of nonglobal molecules in Germany, France, Italy, and Japan is consistent with traditional incentives under their regulatory systems for local manufacturers to develop many minor products that do not diffuse globally.[34]

Mean Generic Entry Lag at the molecule level is roughly 10 years for the United States and Germany compared with 5 years or less for the other countries, despite their higher values for Molecule Age than the United States. Relatively low Generic Entry Lag values for Italy, Japan, and France are consistent with the hypothesis that generically equivalent products in these regulated systems are disproportionately licensees rather than competitive generics, and with a relatively large number of zero values (no generic competition). Relatively high Generic Entry Lag values for the United States and Germany suggest a relatively large number of recent generic entrants but may also reflect different regulatory barriers to generic entry.[35] This same pattern occurs in the sample of molecules launched since 1980.

As expected, mean Pack Size is significantly lower in Germany, France, and Italy, which require unit pack dispensing, than in the United States, Canada, the United Kingdom, and Japan, where pharmacists and/or dispensing physicians are permitted to purchase in bulk and dispense smaller volumes to individual patients. The low Strength per unit in Japan is in part a response to the high drug consumption per capita[36] and common practice of polypharmacy (prescribing several different drugs simultaneously), which may partly reflect the incentives of dispensing physicians to prescribe a high volume of drugs.

B. Regression Analysis

Rather than estimate separate regressions for each country, we pool the data for all seven countries and estimate a fully interacted model as follows:

$$\ln P_{is} = \beta \ln X_{is}D_0 + \delta_s \ln X_{is}D_s + \cdots + \delta_s \ln X_{is}D_s + u_{is}, \qquad (2)$$

[34] For post-1980 molecules, the United States has more Therapeutic Substitute Molecules per ATC than other countries, suggesting that these patterns are changing.

[35] In the United States, the 1984 Waxman Hatch Act gave patent holders up to 5 years of patent extension but also accelerated generic manufacturers' access to the data needed for prompt postpatent entry. The European Union adopted patent extension later and granted the originator firm data exclusivity for 6–10 years, compared with 5 years in the United States. See European Commission, *supra* note 3.

[36] REMIT Consultants, *supra* note 21.

where

$$D_s = \begin{cases} 1 & \text{if country} = s \\ 0 & \text{otherwise,} \end{cases}$$

for $s = 0, \ldots, 6$ ($s = 0$ denotes the United States). The dependent variable, $\ln P_{is}$, is the log price per unit for product i in country s. The variable X is a vector of quality and competition characteristics for that product in country s. Parameter vectors for each country are

$$\begin{aligned} \text{United States} &= \beta, \\ \text{United Kingdom} &= \beta + \delta_{\text{UK}}, \\ \text{Canada} &= \beta + \delta_{\text{CN}}, \end{aligned}$$

and so on. In this form, δ_s measures the country-specific differential between parameter effects for country s and for the United States. The United States is used as the base country because it is the least regulated market for both manufacturer prices and pharmacy margins and prices. This fully interacted model yields the same coefficient estimates as are obtained from separate, country-specific regressions. However, it does give slightly different test statistics since in this pooled form the estimate of the residual variance σ_u^2 is based on the sum of squared residuals over all countries instead of the country-specific residuals. The advantage of this specification is that *t*-statistics for country interactions test for parameter differences between each country and the United States.

Table 3 reports results with the fully interacted model, which allows all parameters to differ across countries. Several of the coefficients are not significant at conventional levels, which suggests that the fully interacted model is too general and not efficient. In Table 4 we therefore report results for a constrained model that suppresses the interaction and imposes parameter equality between the United States and the other country, if the *t*-statistic in the fully interacted model was less than unity. The constraints improve efficiency of the estimates. A test of the joint hypothesis, that all constrained parameters are zero, cannot be rejected, which suggests that any bias from imposing the constraints is small.[37] The discussion here focuses on the constrained estimates. Table 5 reports fully interacted regressions for molecule-level prices, for molecules available in at least five of the seven countries.

[37] The *F*-statistic for the joint hypothesis that the constrained interactions are zero is .35.

TABLE 3

PRODUCT-LEVEL PHARMACEUTICAL PRICES: GLOBAL MOLECULES, PHARMACY—1992: LOG PRICE PER UNIT, FULLY INTERACTED MODEL

Variable	U.S.	Canada	Germany	France	Italy	Japan	U.K.
Intercept	4.919	.397	−1.184	.064	−.663	1.909	−1.227
	(13.987)	(.658)	(−2.077)	(.093)	(−.970)	(3.086)	(−1.659)
Quality:							
Strength (ln)	.096	−.066	.077	.024	.038	.014	.096
	(6.977)	(−2.372)	(3.569)	(.815)	(1.336)	(.569)	(3.146)
Molecule Age (ln)	−.014	−.473	−.289	−.783	−.701	−.789	−.457
	(−.238)	(−4.842)	(−3.343)	(−7.304)	(−6.995)	(−8.045)	(−3.883)
Forms (ln)	−.015	.028	.196	.136	.207	.373	.181
	(−.382)	(−.333)	(3.309)	(1.509)	(2.325)	(4.833)	(1.912)
Competition:							
Pack Size (ln)	−.947	.110	.406	.333	.397	.368	.432
	(−38.157)	(2.437)	(9.145)	(5.432)	(7.113)	(9.422)	(8.270)
Generic Competitors (ln)	−.505	.249	.089	.350	.560	.435	.152
	(−15.656)	(3.542)	(1.829)	(4.220)	(8.121)	(6.805)	(1.720)
Generic Entry Lag (ln)	−.105	.091	.074	.182	.188	.183	.190
	(−6.794)	(3.518)	(3.503)	(6.516)	(6.823)	(7.340)	(6.340)
Therapeutic Substitute Molecules (ln)	.133	.270	−.020	.072	−.149	−.219	−.126
	(3.078)	(2.946)	(−.320)	(.781)	(−1.642)	(−3.375)	(−1.350)
Products per Therapeutic Substitute Molecule (ln)	−.230	−.008	.101	−.207	.554	−.244	.145
	(−5.142)	(−.071)	(1.412)	(−1.289)	(3.956)	(−2.389)	(1.079)

Therapeutic Substitute Molecule Entry Lag (ln)	−.028	.0388	.035	−.044	−.013	.040	.081
	(−2.212)	(1.449)	(1.749)	(−1.496)	(−.464)	(1.700)	(2.699)
Therapeutic categories:							
A	−1.517	.490	1.196	1.448	1.751	1.548	.860
	(−14.056)	(2.544)	(7.748)	(6.700)	(9.665)	(9.637)	(3.607)
B	−1.147	.135	.952	1.255	1.393	.576	.513
	(−7.951)	(.517)	(3.926)	(4.016)	(4.779)	(2.285)	(1.905)
D	−.898	−.443	.495	.255	.495	.222	.510
	(−8.464)	(−1.906)	(2.831)	(1.047)	(2.199)	(1.206)	(2.123)
G	−.169	.532	.224	.589	.431	−.273	.564
	(−1.035)	(1.712)	(.840)	(1.702)	(1.597)	(−.983)	(1.602)
H	.185	−.479	.413	1.075	.438	.482	.617
	(1.347)	(−1.666)	(1.945)	(3.543)	(1.307)	(2.031)	(2.333)
J	.651	−.197	−.299	−.472	−.451	−.799	−.579
	(7.781)	(−1.095)	(−2.097)	(−2.305)	(−2.404)	(−5.008)	(−2.806)
L	.126	−.038	1.248	.494	.704	.940	.166
	(.328)	(−.075)	(2.816)	(.932)	(1.286)	(1.871)	(.319)
M	.307	−.186	−.875	−.703	−.461	−.551	−.479
	(3.278)	(−.943)	(−6.112)	(−2.837)	(−2.226)	(−3.426)	(−2.128)
N	−.255	−1.116	−.802	−.543	.007	−.359	−.583
	(−3.908)	(−7.306)	(−6.794)	(−3.238)	(.039)	(−2.577)	(−3.235)
P	−.170	−.913	−.314	.286	1.396	−1.847	−2.319
	(−.364)	(−.881)	(−.305)	(.276)	(1.353)	(−1.782)	(−2.238)
R	.625	−.820	−.217	−.574	−.608	−.207	−.179
	(6.332)	(−3.816)	(−1.478)	(−2.638)	(−2.837)	(−1.073)	(−.779)
S	−3.073	−.709	.586	.039	1.364	−.313	−.224
	(−12.647)	(−1.296)	(1.430)	(.064)	(2.520)	(−.529)	(−.235)

NOTE.—Adjusted $R^2 = .6215$; t-statistics are in parentheses.

TABLE 4

PRODUCT-LEVEL PHARMACEUTICAL PRICES: GLOBAL MOLECULES, PHARMACY—1992: LOG PRICE PER UNIT, CONSTRAINED MODEL

Variable	U.S.	Canada	Germany	France	Italy	Japan	U.K.
Intercept	4.989	.371	−1.245	.076	−.895	1.697	−1.363
	(15.442)	(.644)	(−2.473)	(.118)	(−1.535)	(2.912)	(−1.893)
Quality:							
Strength (ln)	.103	−.076	.071	. . .	.029	. . .	.091
	(10.150)	(−2.945)	(3.658)		(1.107)		(3.170)
Molecule Age (ln)	−.027	−.465	−.264	−.757	−.664	−.783	−.440
	(−.481)	(−4.919)	(−3.139)	(−7.160)	(−7.709)	(−8.103)	(−3.796)
Forms (ln)	−.005	. . .	.181	.130	.201	.361	.177
	(−.163)		(3.232)	(1.483)	(2.322)	(4.914)	(1.910)
Competition:							
Pack Size (ln)	−.946	.110	.392	.323	.395	.375	.427
	(−39.497)	(2.517)	(9.385)	(5.369)	(7.146)	(10.046)	(8.378)
Generic Competitors (ln)	−.503	.249	.083	.346	.557	.444	.144
	(−16.103)	(3.648)	(1.740)	(4.263)	(8.188)	(7.116)	(1.647)
Generic Entry Lag (ln)	−.104	.088	.072	.180	.187	.182	.189
	(−6.786)	(3.508)	(3.429)	(6.466)	(6.814)	(7.339)	(6.333)
Therapeutic Substitute Molecules (ln)	.130	.258	. . .	. . .	−.155	−.200	−.110
	(4.549)	(3.146)			(−2.048)	(−3.697)	(−1.289)
Products per Therapeutic Substitute Molecule (ln)	−.220	. . .	.079	−.207	.547	−.236	.155
	(−5.699)		(1.197)	(−1.324)	(4.173)	(−2.402)	(1.210)

Therapeutic Substitute Molecule Entry Lag (ln)	−.027	.029	.032	−.035	...	.039	.079
	(−2.517)	(1.198)	(1.762)	(−1.270)		(1.731)	(2.738)
Therapeutic categories:							
A	−1.526	.532	1.181	1.394	1.755	1.603	.918
	(−15.587)	(3.181)	(8.425)	(7.171)	(10.603)	(10.892)	(4.194)
B	−1.098	...	.886	1.148	1.335	.591	.507
	(−9.573)		(4.061)	(3.997)	(4.843)	(2.587)	(2.070)
D	−.885	−.392	.440	.180	.465	.245	.535
	(−8.885)	(−1.873)	(2.650)	(.782)	(2.242)	(1.395)	(2.365)
G	−.170	.539	...	.492	.442	...	.614
	(−1.560)	(2.017)		(1.633)	(1.887)		(1.928)
H	.193	−.449	.369	.992	.389	.526	.650
	(1.447)	(−1.623)	(1.796)	(3.363)	(1.240)	(2.285)	(2.565)
J	.629	−.142	−.300	−.499	−.430	−.712	−.520
	(8.361)	(−.918)	(−2.359)	(−2.749)	(−2.420)	(−5.086)	(−2.710)
L	.289	...	1.066	...	.522	.841	...
	(1.650)		(3.846)		(1.247)	(2.316)	
M	.261	...	−.861	−.660	−.430	−.482	−.403
	(3.245)		(−6.524)	(−2.794)	(−2.437)	(−3.165)	(−1.902)
N	−.266	−1.047	−.829	−.517	...	−.294	−.540
	(−4.579)	(−8.230)	(−7.592)	(−3.319)		(−2.255)	(−3.233)
P	−.313	...	...	...	1.512	−1.564	−2.142
	(−.895)				(1.545)	(−1.593)	(−2.173)
R	.596	−.771	−.207	−.625	−.584	−.122	...
	(7.013)	(−3.880)	(−1.546)	(−3.099)	(−2.933)	(−.672)	
S	−3.100	−.616	.557	...	1.411	...	...
	(−15.628)	(−1.191)	(1.460)		(2.760)		

NOTE.—Adjusted $R^2 = .6215$; t-statistics are in parentheses.

1. Quality

Price is increasing in Strength, which is as expected if therapeutic value increases with strength. Price is independent of the number of presentation forms in the United States and Canada. For other countries, the elasticity is significantly positive, consistent with the hypothesis that introducing line extensions is a method of obtaining a price increase in countries that do not permit price increases for established products. The price elasticity with respect to the number of forms is largest in Japan, which has the most negative decline in price over the product life cycle[38] and hence strong incentives to introduce ''new'' forms to get a higher price.

Molecule Age is not significantly related to product price in the United States for this product-level sample, but this reflects the predominance of generics. Competitive generic prices are expected to approximate the marginal cost of production, which may be unrelated to the therapeutic value of the molecule. Molecule level prices are negatively related to Molecule Age (see Table 5), consistent with the hypothesis that molecule age is an inverse indicator of relative quality. For all other countries the Molecule Age interactions are significantly negative, as expected given regulatory restrictions on postlaunch price increases and weaker generic competition. The Molecule Age elasticity is most negative (−.66 or greater) for France, Italy, and Japan, which have the strictest price regulation. Note that the full price-age effect for any product is the combined effect of its Molecule Age and its Generic Entry Lag relative to the first product in that molecule. Since the Generic Entry Lag coefficient is significantly more negative for the United States than for other countries, the combined price-age effect for any product differs less between countries than appears from the Molecule Age coefficients alone. However, this decomposition suggests that the price decline with age is more attributable to competition in the United States and more to regulation in other countries.

For the United States, eight of the 12 ATC category dummies are significant at conventional levels relative to cardiovasculars, implying significant differences in average prices for different indications. The significant country-ATC interaction terms imply that therapeutic category effects differ across countries, owing to such factors as category-specific differences in medical norms, insurance, regulation, and OTC share.

2. Competition

Pack Size. The elasticity of unit price with respect to pack size for the United States is −.95, with positive interactions for all other countries that

[38] Danzon & Kim, *supra* note 32.

imply elasticities at least one-third lower (except Canada). This implies more significant volume discounts to pharmacists for bulk purchasing in the United States than in other countries, which is consistent with more price-sensitive pharmacy purchasers in the United States.[39] In Germany, France, and Italy the weak volume discounts are consistent with expectations given unit pack dispensing requirements and other impediments to price competition in retail pharmacy, which make the derived demand facing manufacturers less elastic, undermining incentives to give volume discounts.[40] These findings suggest that unit pack dispensing requirements lead to significant forgone pack-size economies, in addition to other possible costs of these regulatory restrictions on pack splitting, such as costs of providing a greater number of different pack sizes and possibly more waste if the available packs are larger than required for the individual prescription. The unexpectedly large positive pack-size interaction for the United Kingdom may be biased because of the omission of discounts to pharmacists, which are likely to be largest on large packs.

Generic Competitors. The price elasticity with respect to the number of generic competitors in the United States is −.50. Positive interactions for other countries imply that generic competition has a weaker effect on price in all other countries. The difference is smallest and only marginally significant in Germany and the United Kingdom, both of which have reference price systems for multisource drugs that encourage price competition, followed by Canada, which also promotes generic competition. By contrast, the net association between generic competitors and price is positive (+.06) in Italy and negligibly small in Japan (−.06) and France (−.15). In France and Italy, the absence of price competition plausibly reflects the lack of incentive for price sensitivity on the part of patients, physicians, or pharmacists.[41] For Japan, physicians' sensitivity is with respect to the dispensing margin, which may be negatively correlated with the observed price P^t, owing

[39] Note that mean Pack Size is larger in Canada and Japan, although their price–pack-size discounts are smaller than in the United States. Thus the greater U.S. pack-size price discounts cannot be attributed to larger average pack size in the United States.

[40] In regressions for younger molecules (under 15 years old, not reported here), the pack-size elasticity for the United States is −.35 compared to −.95 for the full sample. The more negative pack-size elasticity in the full regression sample dominated by generics suggests larger discounts by generics, consistent with relatively elastic pharmacists' demand for off-patent drugs, for which pharmacists select the product to dispense. For the other countries, the pack-size elasticities are similar for both samples, indicating a smaller difference between generics and branded drugs.

[41] Co-payments have since been increased in Italy and have significantly affected demand. See Eugenio Anessi, The Effect of User Charges on the Utilization of Prescription Drugs in the Italian National Health Service (unpublished doctoral dissertation, Univ. Pennsylvania, Wharton Sch. 1997).

to the link between reimbursement in period t and price in period $t - 2$, which is plausibly correlated with P^t. This evidence is also consistent with the expectation that multisource products in France, Italy, and Japan are disproportionately either licensed co-marketers with little incentive to compete on price or new forms of old molecules that are introduced to obtain a higher regulated price when prices of older forms have dropped. Some of these new versions of old molecules may offer real quality improvements, such as a delayed release form. However, such quality improvements occur in all countries. The difference is that in countries that promote price competition, the price-increasing effect of new formulations is dominated by the price-decreasing effect of competitive generics, whereas the reverse is true in the highly regulated markets of France, Italy, and Japan.

As further evidence on this, the negative elasticity of price with respect to Generic Entry Lag (−.10) implies a first-mover advantage for originator products in the United States, with successive generic entrants receiving lower prices. The positive interactions for Canada and Germany are sufficiently large to imply no price differentials based on time of entry. For France, Italy, and Japan the later entrants appear to receive positive price premiums, which is consistent with expected regulatory effects in these countries. For the United Kingdom, the positive entry lag premium may reflect relatively large measurement error for late entrants, due to omitted discounts;[42] the role of parallel imports, which are less price competitive and enter earlier than true generics (mean Generic Entry Lag is 100 months in the United Kingdom versus 208 months in the United States); and the relatively small number of generic entrants in the United Kingdom (mean number of Generic Competitors per molecule is 2.3 in the United Kingdom versus 6.6 in Germany and 11.1 in the United States).[43]

The effects of generic competition carry over to molecule-level prices (Table 5). The molecule price elasticity with respect to the number of generic competitors is −.49 in the United States, with no significant difference in Canada and a small positive interaction for Germany. For France, Italy, and Japan the molecule price elasticities with respect to the number of generic competitors are positive (.04, .20, and .13, respectively), consis-

[42] The U.K. Drug Tariff for molecules with multiple generics is based on the prices of the largest wholesalers. If late entrants give the largest discounts, the upward bias in the IMS data would be positively correlated with Generic Entry Lag. This remains an untested hypothesis.

[43] Originator products in the United States tend to raise price after patent expiration, pursuing a market segmentation strategy. See Richard G. Frank & David S. Salkever, Pricing, Patent Loss and the Market for Pharmaceuticals, 59 S. Econ. J. 165 (1992); Grabowski & Vernon, *supra* note 1. However, this tendency is unlikely to explain the more negative Generic Entry Lag coefficient in the United States because originator brands are only a small fraction of the U.S. sample.

tent with the product-level evidence of lack of generic competition. The U.K. elasticity is negative (−.15) but significantly smaller than that of the United States, Canada, and Germany. As noted, this U.K. estimate may be biased because of omitted discounts on generics.

Our estimates may underestimate the negative effect of Generic Competitors on price due to reverse causation, if the number of generic entrants is positively related to price expectations, which are positively correlated with observed prices. This potential bias exists in all countries and hence cannot explain cross-country differences. Indeed, if regulation of originator prices undermines incentives for postpatent generic entry, the positive endogeneity bias in our coefficient estimates is greatest for unregulated countries. In other words, our estimates may understate the true extent to which regulation undermines price competition between generically equivalent drugs.

Therapeutic Substitutes. Price competition is weaker between Therapeutic Substitute Molecules than between Generic Competitor Products, as expected. In Tables 3 and 4, price is positively related to the number of Therapeutic Substitute Molecules with an ''elasticity'' of .13 for the United States, Germany, France, and the United Kingdom; a positive interaction for Canada; and a significant negative interaction for Japan and Italy. However, the price elasticity with respect to Products per Substitute Molecule is significantly negative (−.22) for the United States, with a significant negative interaction for Japan (net effect −.46), but a net positive effect in Italy (.33). Thus, in this sample of global compounds, generic competition appears to be the dominant competitive factor, enhancing between-molecule competition by therapeutic substitute molecules as well as within-molecule competition by generic competitors (except in Italy). However, the magnitude of effects is sensitive to specification, as shown in Table 6. If therapeutic substitutes are defined simply as Total Products in all other molecules in the therapeutic category, without distinction between the number of molecules and products per molecule, then the coefficient is negative (−.07) for the United States, with significant positive interactions for Canada and Italy, and a significant negative interaction only for Japan. If Therapeutic Substitute Molecules is included alone, its effect is positive and similar to the specification that includes Products per Substitute Molecule. Adding an interaction between Therapeutic Substitute Molecules and Products per Substitute Molecule results in offsetting signs but does not add overall explanatory power.

Although the number of Therapeutic Substitute Molecules does not appear to exert competitive pressure on price, the fact that successive entrants receive lower prices implies a more limited form of competition. The price elasticity with respect to Therapeutic Substitute Molecule Entry Lag is negative for the United States (−.027), with no significant difference across

TABLE 5

MOLECULE-LEVEL PHARMACEUTICAL PRICES: FIVE-COUNTRY MATCHED MOLECULES, PHARMACY—1992: LOG PRICE PER UNIT, FULLY INTERACTED MODEL

Variable	U.S.	Canada	Germany	France	Italy	Japan	U.K.
Intercept	4.307	.815	−.173	.145	.186	2.785	.255
	(8.998)	(1.248)	(−.250)	(.222)	(.281)	(3.666)	(.371)
Quality:							
Strength (ln)	.104	−.038	.034	.015	.060	−.060	.023
	(4.286)	(−1.085)	(.996)	(.446)	(1.729)	(−1.633)	(.640)
Molecule Age (ln)	−.193	−.252	−.193	−.406	−.437	−.671	−.419
	(−2.649)	(−2.598)	(−1.961)	(−4.161)	(−4.643)	(−6.168)	(−3.993)
Forms (ln)	.210	.005	.103	−.110	−.007	−.078	−.084
	(2.422)	(.038)	(.860)	(−.877)	(−.057)	(−.594)	(−.680)
Competition:							
Pack Size (ln)	−.828	.074	.234	.081	.177	.117	.224
	(−14.422)	(.964)	(2.861)	(1.011)	(2.202)	(1.539)	(2.827)
Generic Competitors (ln)	−.487	.075	.139	.526	.693	.615	.342
	(−10.329)	(.802)	(1.930)	(5.343)	(8.348)	(7.855)	(3.513)
Therapeutic Substitute Molecules (ln)	.111	−.100	−.207	−.247	−.242	−.137	−.171
	(1.344)	(−.826)	(−1.873)	(−2.144)	(−2.227)	(−1.220)	(−1.511)
Therapeutic Substitute Molecule Entry Lag (ln)	−.009	−.023	.024	.023	−.006	.009	.030
	(−.315)	(−.578)	(.636)	(.576)	(−.150)	(.230)	(.788)

Therapeutic categories:							
A	−.854	.318	.541	.970	.961	.671	.482
	(−4.646)	(1.244)	(2.112)	(3.747)	(3.798)	(2.510)	(1.873)
B	−.095	−.092	.135	.147	.244	−.041	−.040
	(−.339)	(−.240)	(.354)	(.387)	(.652)	(−.103)	(−.101)
D	−.787	−.051	.159	.508	.854	−.117	.340
	(−3.874)	(−.179)	(.559)	(1.799)	(3.002)	(−.388)	(1.188)
G	.469	−.414	−.670	−.179	−.140	−.574	−.125
	(1.936)	(−1.172)	(−2.013)	(−.516)	(−.418)	(−1.630)	(−.362)
H	−.091	−.133	.594	.400	.266	.110	.183
	(−.308)	(−.313)	(1.419)	(.940)	(.641)	(.255)	(.407)
J	.685	−.414	−.036	−.552	−.080	−.066	−.036
	(3.366)	(−1.398)	(−.123)	(−1.843)	(−.279)	(−.219)	(−.123)
L	.572	.019	.740	.312	.406	.475	.459
	(1.992)	(.049)	(1.902)	(.788)	(1.047)	(1.066)	(1.128)
M	−.006	.352	−.456	−.265	−.041	−.232	.294
	(−.029)	(1.108)	(−1.494)	(−.852)	(−.132)	(−.739)	(.960)
N	.120	−.463	−.617	−.448	−.223	−.468	−.265
	(.703)	(−1.928)	(−2.614)	(−1.867)	(−.949)	(−1.884)	(−1.106)
P	.069	−.934	−.739	−.369	−.545	−1.569	−1.458
	(.178)	(−1.633)	(−1.280)	(−.650)	(−.889)	(−1.587)	(−2.665)
R	−.069	−.420	−.049	.115	.129	.179	−.076
	(−.312)	(−1.366)	(−.162)	(.372)	(.430)	(.577)	(−.256)
S	−2.510	−.244	−.081	.138	.750	−.078	.540
	(−7.587)	(−.549)	(−.187)	(.314)	(1.772)	(−.168)	(1.171)
N	354	361	394	365	388	330	363

NOTE.—Adjusted $R^2 = .643$. Total $N = 2{,}555$.

countries except for a small positive interaction (.079) for the United Kingdom. This evidence implies a much smaller first-mover advantage between molecules than within molecules, as expected if successive molecules in a class can offer real improvement over the first entrant, whereas generic imitators offer little or no improvement over the originator product.

The apparent lack of competitive effect of the number of Therapeutic Substitute Molecules is contrary to other evidence and may reflect limitations of our data, in particular, the relatively old sample, endogeneity bias, omitted variable bias, and/or measurement error.[44] To shed some light on these alternatives, we reestimated the model with different samples and different specifications. We reestimated the model limiting the sample to molecules launched since 1980 and present in at least five of the seven countries (the G5 age $\leq$ 12 sample). In this younger cohort with fewer generics, the estimates should reflect between-molecule effects more than within-molecule effects. For the United States, the coefficient of Therapeutic Substitutes is larger (.314) for this young cohort than for the all-ages, global molecules. Country interactions are significantly negative for all other countries except Canada. A plausible explanation of these findings is that endogeneity and omitted promotional spending are more important for recent molecules than for older molecules, and the demand-expanding effect of promotion can affect price and volume in the United States, whereas only volume can be affected in price-regulated regimes.

Endogeneity may bias upward our estimates of competition between therapeutic substitutes, if entry of substitute molecules is positively related to expected prices, which are positively correlated with current prices. As a rough control for size of the therapeutic category, we included a dummy variable for single-molecule therapeutic categories. For the full sample the expected coefficient is negative, assuming that categories that remain exclusive are very small; for the young cohort (G5 age $\leq$ 12) the expected coefficient could be positive if market power is greater in single-molecule categories. In all age samples, the coefficient of the single-molecule dummy was negative, suggesting that the number of therapeutic substitutes is related to market size and profitability. The coefficient of Therapeutic Substitute Molecules remained positive.

We also estimated the basic model using the molecule as the unit of observation (Table 5), with the sample expanded to include molecules in five

[44] Boston Consulting Group, The Changing Environment of US Pharmaceuticals (1993), reports that later entrants to a therapeutic category entered at an average 14 percent discount in list price relative to the market leader, and the mean discount in more crowded therapeutic categories was over 30 percent. See Ellison, *supra* note 1, which shows fairly high cross-price elasticities between generic substitutes and smaller but sometimes significant elasticities between therapeutic substitutes in its study of cephalosporins in 1985–91.

countries, in an attempt to obtain better evidence of between-molecule competition. Conclusions for generic competition carry through from the product to the molecule level, as noted earlier. However, Therapeutic Substitute Molecules has no significant effect on molecule price in the United States and Canada and is negative but not highly significant for the other countries in the fully interacted model.

Omitted variable bias due to unobserved, promotional investment by originator products may contribute positive bias in our estimates of price elasticity with respect to the number of molecules. Promotion in the United States is undertaken primarily by originator products while on patent.[45] If promotion expands the total market, rather than simply eroding competitors' sales, this promotion-induced market expansion is expected to be positively correlated with the number of molecules in a class but negatively or uncorrelated with products per molecule, owing to potential spillover of benefits to competitors. This hypothesis of omitted variable bias remains untested because we lack data on promotion. Similarly, our U.S. data are inadequate to measure competition in the form of discounts to managed care purchasers, which is a major channel for therapeutic competition. Moreover, these 1992 data would almost certainly understate therapeutic competition in the late 1990s, as therapeutic categories have become more crowded, managed care has spread in the United States, and the United Kingdom and Germany have adopted incentive programs to induce more price-sensitive prescribing by physicians.

In summary, there is evidence of competition between therapeutic substitutes in the form of lower prices for successive entrants. Controlling for this, the number of molecules in a class does not appear to add a net competitive effect, but these estimates may be biased, because these data are inadequate to control for endogeneity of the number of molecules, for demand-shifting promotional investment, and for competitive discounts in the United States and possibly the United Kingdom. Although the number of Therapeutic Substitute Molecules appears to have a more negative effect on price in the regulated markets of Italy and Japan, this is more likely to reflect regulation rather than competition, in particular, regulation of new product prices based on prices of established products that have declined in real terms. These countries show no evidence of generic competition, although generics are much closer substitutes; indeed, the net competitive effects of both Generic Competitors and Therapeutic Substitute Molecules are not significantly different from zero in these two countries. These regulatory systems thus appear to provide indistinguishable price incentives for investment in innovative and imitative R&D. These findings are consistent

[45] Caves *et al., supra* note 24.

TABLE 6

PRODUCT-LEVEL PHARMACEUTICAL PRICES: GLOBAL MOLECULES, PHARMACY—1992: LOG PRICE PER UNIT, DIFFERENT SPECIFICATIONS FOR GENERIC AND THERAPEUTIC COMPETITORS

SPECIFICATION 1							
Variable	U.S.	Canada	Germany	France	Italy	Japan	U.K.
Generic Competitor Products (ln)	−.494	.193	.065	.308	.538	.414	.125
	(−15.315)	(2.780)	(1.358)	(3.802)	(7.752)	(6.464)	(1.450)
Generic Entry Lag (ln)	−.106	.096	.077	.182	.192	.185	.189
	(−6.766)	(3.672)	(3.588)	(6.461)	(6.906)	(7.348)	(6.239)
Total Products in All Other Molecules in ATC3 (ln)	−.068	.220	.086	.089	.140	−.103	.056
	(−2.315)	(3.519)	(1.901)	(1.317)	(2.616)	(−2.159)	(.799)
SPECIFICATION 2							
Variable	U.S.	Canada	Germany	France	Italy	Japan	U.K.
Generic Competitor Products (ln)	−.500	.232	.074	.304	.553	.407	.131
	(−15.425)	(3.288)	(1.517)	(3.705)	(7.967)	(6.345)	(1.537)
Generic Entry Lag (ln)	−.109	.096	.079	.187	.195	.189	.194
	(−6.988)	(3.692)	(3.682)	(6.662)	(7.021)	(7.506)	(6.429)
Total Products in All Other Molecules in ATC3 (ln)	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Therapeutic Substitute Molecules (ln)	.137	.252	−.014	.039	−.049	−.249	−.126
	(3.136)	(2.739)	(−.221)	(.429)	(−.609)	(−3.836)	(−1.347)

Products per Therapeutic Substitute Molecule (ln)	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Therapeutic Substitute Molecule Entry Lag (ln)	−.044	.049	.045	−.021	−.003	.037	.091
	(−3.589)	(1.843)	(2.291)	(−.717)	(−.113)	(1.594)	(3.178)

SPECIFICATION 3

Variable	U.S.	Canada	Germany	France	Italy	Japan	U.K.
Generic Competitor Products (ln)	−.494	.257	.086	.374	.553	.432	.180
	(−15.460)	(3.667)	(1.785)	(4.452)	(8.072)	(6.806)	(2.054)
Generic Entry Lag (ln)	−.107	.091	.077	.182	.190	.185	.190
	(−6.950)	(3.540)	(3.650)	(6.585)	(6.934)	(7.455)	(6.407)
Total Products in All Other Molecules in ATC3 (ln)	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Therapeutic Substitute Molecules (ln)	.441	.080	−.208	−.149	−.478	−.349	−.389
	(8.030)	(.768)	(−2.774)	(−1.454)	(−4.462)	(−4.302)	(−3.880)
Interaction between Therapeutic Substitute Molecule and Products per Substitute Molecule (ln)	−.224	.009	.081	−.041	.325	−.032	.063
	(−8.896)	(.138)	(2.078)	(−.490)	(5.719)	(−.617)	(.817)
Therapeutic Substitute Molecule Entry Lag (ln)	−.024	.030	.029	−.051	−.015	.033	.084
	(−1.963)	(1.143)	(1.483)	(−1.737)	(−.520)	(1.437)	(2.912)

with the evidence[46] that these two countries have produced a large number of minor new products but few truly innovative molecules that have achieved global diffusion.

VI. Accounting for Mean Price Differentials

This section reports our attempt to explain the mean foreign/U.S. (log) price difference in terms of differences in country-specific characteristics and differences in parameter effects, using the regression results reported in Table 4. The (log) mean price difference for country *s* relative to the United States can be written as

$$\ln R = \ln(P_s/P_0) = \ln P_s - \ln P_0 = \ln X_s\beta_s - \ln X_0\beta_0. \quad (3)$$

Comparing equations (2) and (3), we have

$$\beta = \beta_0,$$
$$\delta_s = \beta_s - \beta_0,$$

or

$$\beta_s = \beta_0 + \delta_s.$$

Equation (3) can be rewritten as

$$\ln R = \ln X_s(\beta_0 + \delta_s) - \ln X_0\beta_0 = (\ln X_s - \ln X_0)\beta_0 + \ln X_s\delta_s. \quad (3')$$

The mean price ratio can thus be decomposed into two components. The first component is the effect of country-specific characteristics or the main effect, $(\ln X_s - \ln X_0)\beta_0$, which reflects the difference in mean characteristics of products in country *s* relative to the United States, evaluated at U.S. parameter values. The second component, $\ln X_s\beta_s$, is the interaction or parameter effect, which reflects the difference in impact of characteristics on prices in country *s* compared to the United States. Since the regressions include country intercepts, the estimates are forced through the geometric mean of prices for each country. The coefficient of the country intercept estimates (with opposite sign) the mean unexplained country residual effect that is not explained by differences in measured characteristics or their parameter effects. It also subsumes country effects for the cardiovascular category, which is the omitted category. The results of this decomposition are reported for each country separately in Table 7.

The main factor that contributes to lower prices in other countries relative to the United States is lower returns to Molecule Age, which is the expected

[46] Barral, *supra* note 19.

TABLE 7

ACCOUNTING FOR OBSERVED PRICE RATIOS

A. CANADA VERSUS THE UNITED STATES

VARIABLE	MEAN		COEFFICIENT		MAIN EFFECT	INTERACTION	TOTAL
	U.S.	Canada	U.S.	Canada			
Quality:							
Strength	−2.7717	−2.8511	.1031	−.0755	−.0082	.2153	.2071
Molecule Age	5.6184	5.5598	−.0267	−.4648	.0016	−2.5844	−2.5828
Forms	.8055	.7227	−.0054	···	.0005	···	.0005
Quality subtotal					−.0062	−2.3691	−2.3753
Competition:							
Pack Size	4.8561	4.9145	−.9458	.1098	−.0553	.5398	.4845
Generic Competitors	3.0053	1.5515	−.5031	.2494	.7313	.3870	1.1183
Generic Entry Lag	4.7240	3.2895	−.1041	.0876	.1494	.2881	.4375
Therapeutic Substitute Molecules	2.1625	1.9066	.1297	.2580	−.0332	.4919	.4587
Products per Therapeutic Substitute Molecule	1.7655	.7095	−.2205	···	.2329	···	.2329
Therapeutic Substitute Molecule Entry Lag	3.4977	3.0984	−.0274	.0289	.0109	.0895	.1004
Competition subtotal					1.0360	1.7964	2.8324
Therapeutic categories:							
A	.0640	.1071	−1.5257	.5322	−.0658	.0570	−.0088
B	.0325	.0536	−1.0976	···	−.0231	···	−.0231
D	.0661	.0643	−.8847	−.3923	.0016	−.0252	−.0236
G	.0294	.0339	−.1697	.5387	−.0008	.0183	.0175
H	.0315	.0304	.1930	−.4490	−.0002	−.0136	−.0139
J	.1333	.1214	.6287	−.1421	−.0074	−.0173	−.0247
L	.0032	.0161	.2888	···	.0037	···	.0037
M	.0724	.0946	.2614	···	.0058	···	.0058
N	.2833	.2054	−.2660	−1.0470	.0207	−.2150	−.1943
P	.0021	.0018	−.3125	···	.0001	···	.0001
R	.0682	.0625	.5957	−.7710	−.0034	−.0482	−.0516
S	.0089	.0071	−3.0996	−.6164	.0055	−.0044	.0011
Therapeutic categories subtotal					−.0632	−.2484	−.3116
Residual intercept	1.0000	1.0000	4.9894	.3708	.0000	.3708	.3708
Residual subtotal					.0000	.3708	.3708
Total: log of observed price ratios							.5163

effect of most regulatory systems. The Molecule Age interaction effects are the most negative in countries with stringent price regulation (−3.6 for Italy, −4.2 for France, and −4.4 for Japan), implying predicted effects that are several times greater than the total mean price differential.[47] These negative Molecule Age effects are partly offset by positive Generic Entry Lag effects, but the overall age effect is still negative under regulation.

The main offsetting factor that increases prices in regulated countries rel-

[47] Using a larger sample including nonglobal molecules, Danzon & Chao, *supra* note 9, shows that regulated systems also give lower returns to ''therapeutic merit,'' as measured by the number of countries to which a molecule has diffused.

TABLE 7 (*Continued*)

B. Germany versus the United States

Variable	Mean		Coefficient		Main Effect	Interaction	Total
	U.S.	Germany	U.S.	Germany			
Quality:							
Strength	−2.7717	−2.7716	.1031	.0705	.0000	−.1955	−.1955
Molecule Age	5.6184	5.6809	−.0267	−.2642	−.0017	−1.5011	−1.5028
Forms	.8055	.7681	−.0054	.1810	.0002	.1390	.1392
Quality subtotal					−.0015	−1.5576	−1.5590
Competition:							
Pack Size	4.8561	3.7917	−.9458	.3921	1.0066	1.4869	2.4935
Generic Competitors	3.0053	2.4162	−.5031	.0827	.2963	.1997	.4961
Generic Entry Lag	4.7240	4.0447	−.1041	.0725	.0707	.2932	.3639
Therapeutic Substitute Molecules	2.1625	2.4579	.1297	...	.0383	...	.0383
Products per Therapeutic Substitute Molecule	1.7655	1.0287	−.2205	.0791	.1625	.0814	.2438
Therapeutic Substitute Molecule Entry Lag	3.4977	4.2894	−.0274	.0329	−.0217	.1411	.1195
Competition subtotal					1.5528	2.2022	3.7551
Therapeutic categories:							
A	.0640	.1071	−1.5257	1.1809	−.0657	.1265	.0607
B	.0325	.0239	−1.0976	.8861	.0095	.0212	.0307
D	.0661	.0575	−.8847	.4399	.0076	.0253	.0329
G	.0294	.0239	−.1697	...	.0009	...	.0009
H	.0315	.0398	.1930	.3686	.0016	.0147	.0163
J	.1333	.1230	.6287	−.2998	−.0065	−.0369	−.0433
L	.0032	.0177	.2888	1.0664	.0042	.0189	.0231
M	.0724	.1159	.2614	−.8612	.0114	−.0998	−.0885
N	.2833	.1558	−.2660	−.8290	.0339	−.1291	−.0952
P	.0021	.0009	−.3125	...	.0004	...	.0004
R	.0682	.0991	.5957	−.2065	.0184	−.0205	−.0021
S	.0089	.0080	−3.0996	.5571	.0030	.0044	.0074
Therapeutic categories subtotal					.0187	−.0754	−.0567
Residual intercept	1.0000	1.0000	4.9894	−1.2447	.0000	−1.2447	−1.2447
Residual subtotal					.0000	−1.2447	−1.2447
Total: log of observed price ratios							.8946

ative to the United States is less generic price competition, with fewer generics, less price competition between generics, and less negative returns to late generic entrants. These three components—fewer generics, less generic price competition, and less competitive late entrants—are consistent with incentives in regulated environments: low regulated prices for originator products by patent expiration discourage generic entry, the incentives for price-competitive generic strategies are less owing to price-insensitive purchasers, and the incentives for price-increasing generic strategies are greater. The measured effect of generic competition most similar to the United States is that for Germany, where reference pricing combined with

TABLE 7 (*Continued*)

C. France versus the United States

Variable	Mean		Coefficient		Main Effect	Interaction	Total
	U.S.	France	U.S.	France			
Quality:							
Strength	−2.7717	−2.6734	.1031	...	.0101	...	.0101
Molecule Age	5.6184	5.5658	−.0267	−.7570	.0014	−4.2134	−4.2120
Forms	.8055	.5496	−.0054	.1302	.0014	.0715	.0729
Quality subtotal					.0129	−4.1418	−4.1289
Competition:							
Pack Size	4.8561	3.2026	−.9458	.3225	1.5638	1.0329	2.5966
Generic Competitors	3.0053	1.1927	−.5031	.3457	.9118	.4123	1.3242
Generic Entry Lag	4.7240	2.5751	−.1041	.1796	.2238	.4624	.6861
Therapeutic Substitute Molecules	2.1625	2.2207	.1297	...	.0076	...	.0076
Products per Therapeutic Substitute Molecule	1.7655	.4133	−.2205	−.2069	.2982	−.0855	.2127
Therapeutic Substitute Molecule Entry Lag	3.4977	3.8216	−.0274	−.0348	−.0089	−.1332	−.1420
Competition subtotal					2.9962	1.6889	4.6851
Therapeutic categories:							
A	.0640	.1136	−1.5257	1.3944	−.0756	.1584	.0827
B	.0325	.0346	−1.0976	1.1482	−.0022	.0397	.0375
D	.0661	.0593	−.8847	.1805	.0061	.0107	.0168
G	.0294	.0321	−.1697	.4919	−.0005	.0158	.0153
H	.0315	.0395	.1930	.9920	.0016	.0392	.0407
J	.1333	.1506	.6287	−.4993	.0109	−.0752	−.0643
L	.0032	.0173	.2888	...	.0041	...	.0041
M	.0724	.0568	.2614	−.6603	−.0041	−.0375	−.0416
N	.2833	.1827	−.2660	−.5170	.0268	−.0945	−.0677
P	.0021	.0025	−.3125	...	−.0001	...	−.0001
R	.0682	.0963	.5957	−.6252	.0167	−.0602	−.0435
S	.0089	.0074	−3.0996	...	.0047	...	.0047
Therapeutic categories subtotal					−.0118	−.0036	−.0154
Residual intercept	1.0000	1.0000	4.9894	.0760	.0000	.0760	.0760
Residual subtotal					.0000	.0760	.0760
Total: log of observed price ratios							.6169

free originator pricing encourage generic entry and competition. The U.K. price competitive effect per generic is similar and may be underestimated owing to omitted discounts in our data. However, the total generic effect appears weaker in the United Kingdom than in the United States or Germany, because the number of generics per molecule is much lower.

The second effect of the competitive pharmacy environment that reduces prices in the United States and Canada, relative to other countries, is larger mean pack size and greater volume discounts for large pack sizes. In Germany, France, and Italy, which have the most heavily regulated retail pharmacy, including unit pack dispensing requirements, the positive pack-size

TABLE 7 (*Continued*)

D. Italy versus the United States

Variable	Mean		Coefficient		Main Effect	Interaction	Total
	U.S.	Italy	U.S.	Italy			
Quality:							
Strength	−2.7717	−2.5512	.1031	.0293	.0227	−.0747	−.0520
Molecule Age	5.6184	5.4250	−.0267	−.6636	.0052	−3.5999	−3.5948
Forms	.8055	.6076	−.0054	.2007	.0011	.1219	.1230
Quality subtotal					.0290	−3.5527	−3.5238
Competition:							
Pack Size	4.8561	3.1432	−.9458	.3950	1.6199	1.2415	2.8614
Generic Competitors	3.0053	1.4976	−.5031	.5571	.7584	.8344	1.5928
Generic Entry Lag	4.7240	2.5420	−.1041	.1875	.2272	.4766	.7038
Therapeutic Substitute Molecules	2.1625	2.4746	.1297	−.1548	.0405	−.3832	−.3427
Products per Therapeutic Substitute Molecule	1.7655	.7061	−.2205	.5473	.2336	.3865	.6201
Therapeutic Substitute Molecule Entry Lag	3.4977	4.0709	−.0274	...	.0157	...	−.0157
Competition subtotal					2.8640	2.5557	5.4197
Therapeutic categories:							
A	.0640	.1774	−1.5257	1.7551	−.1730	.3113	.1383
B	.0325	.0312	−1.0976	1.3351	.0015	.0416	.0431
D	.0661	.0604	−.8847	.4650	.0050	.0281	.0331
G	.0294	.0507	−.1697	.4425	−.0036	.0224	.0188
H	.0315	.0234	.1930	.3894	−.0016	.0091	.0076
J	.1333	.1482	.6287	−.4299	.0094	−.0637	−.0543
L	.0032	.0117	.2888	.5220	.0025	.0061	.0086
M	.0724	.1209	.2614	−.4297	.0127	−.0519	−.0393
N	.2833	.1228	−.2660	...	.0427	...	.0427
P	.0021	.0020	−.3125	1.5121	.0001	.0030	.0030
R	.0682	.0643	.5957	−.5840	−.0023	−.0376	−.0399
S	.0089	.0078	−3.0996	1.4113	.0035	.0110	.0145
Therapeutic categories subtotal					−.1033	.2795	.1762
Residual intercept	1.0000	1.0000	4.9894	−.8953	.0000	−.8953	−.8953
Residual subtotal					.0000	−.8953	−.8953
Total: log of observed price ratios							1.1769

effect offsets more than half of the negative Molecule Age effect (in absolute value).

For therapeutic substitution, the effects of the number of Therapeutic Substitute Molecules, Products per Therapeutic Substitute Molecule, and Therapeutic Substitute Entry Lag tend to be offsetting. The combined effect of these three factors appears to be somewhat higher prices in other countries relative to the United States, with the exception of Japan. However, these estimates are likely to be biased by endogeneity, omitted variables, and measurement error; hence conclusions are tentative.

The net effect of therapeutic category differences is small, which is not

TABLE 7 (*Continued*)

E. JAPAN VERSUS THE UNITED STATES

VARIABLE	MEAN		COEFFICIENT		MAIN EFFECT	INTERACTION	TOTAL
	U.S.	Japan	U.S.	Japan			
Quality:							
Strength	−2.7717	−3.1797	.1031	...	−.0421	...	−.0421
Molecule Age	5.6184	5.5682	−.0267	−.7830	.0013	−4.3597	−4.3583
Forms	.8055	.5491	−.0054	.3613	.0014	.1984	.1998
Quality subtotal					−.0394	−4.1613	−4.2006
Competition:							
Pack Size	4.8561	5.6265	−.9458	.3750	−.7286	2.1100	1.3814
Generic Competitors	3.0053	1.9231	−.5031	.4445	.5444	.8548	1.3992
Generic Entry Lag	4.7240	3.4879	−.1041	.1822	.1287	.6356	.7643
Therapeutic Substitute Molecules	2.1625	2.4640	.1297	−.1997	.0391	−.4920	−.4529
Products per Therapeutic Substitute Molecule	1.7655	.9317	−.2205	−.2364	.1839	−.2202	−.0364
Therapeutic Substitute Molecule Entry Lag	3.4977	3.7899	−.0274	.0386	−.0080	.1464	.1384
Competition subtotal					.1595	3.0347	3.1941
Therapeutic categories:							
A	.0640	.1390	−1.5257	1.6035	−.1144	.2229	.1085
B	.0325	.0309	−1.0976	.5905	.0018	.0182	.0200
D	.0661	.0682	−.8847	.2445	−.0019	.0167	.0148
G	.0294	.0309	−.1697	...	−.0003	...	−.0003
H	.0315	.0541	.1930	.5256	.0044	.0284	.0328
J	.1333	.1390	.6287	−.7119	.0036	−.0990	−.0954
L	.0032	.0116	.2888	.8406	.0024	.0097	.0122
M	.0724	.1274	.2614	−.4818	.0144	−.0614	−.0470
N	.2833	.1364	−.2660	−.2938	.0391	−.0401	−.0010
P	.0021	.0013	−.3125	−1.5637	.0003	−.0020	−.0018
R	.0682	.0515	.5957	−.1217	−.0100	−.0063	−.0162
S	.0089	.0039	−3.0996	...	.0157	...	.0157
Therapeutic categories subtotal					−.0449	.0873	.0423
Residual intercept	1.0000	1.0000	4.9894	1.6972	.0000	1.6972	1.6972
Residual subtotal					.0000	1.6972	1.6972
Total: log of observed price ratios							.7330

surprising in this sample that is restricted to the same molecules in all countries. Larger therapeutic differences are likely in the full universe of products in each country. The country intercepts are significant and negative for Germany, Italy, and the United Kingdom and positive for Japan. Since the predicted values pass through the geometric means of the observed values, by construction, these negative country intercepts imply that predicted values based solely on measured characteristics exceed the actual values. In other words, there are large, country-specific effects—such as insurance coverage, medical norms, and reimbursement incentives—that partly offset the differential impact of the variables included in the regressions.

TABLE 7 (*Continued*)

F. United Kingdom versus the United States

Variable	Mean		Coefficient		Main Effect	Interaction	Total
	U.S.	U.K.	U.S.	U.K.			
Quality:							
Strength	−2.7717	−2.9089	.1031	.0913	−.0142	−.2656	−.2798
Molecule Age	5.6184	5.6264	−.0267	−.4403	−.0002	−2.4770	−2.4772
Forms	.8055	.7736	−.0054	.1767	.0002	.1367	.1369
Quality subtotal					−.0142	−2.6059	−2.6201
Competition:							
Pack Size	4.8561	4.1144	−.9458	.4269	.7014	1.7564	2.4578
Generic Competitors	3.0053	1.1880	−.5031	.1435	.9142	.1705	1.0847
Generic Entry Lag	4.7240	2.5586	−.1041	.1892	.2255	.4840	.7094
Therapeutic Substitute Molecules	2.1625	2.0167	.1297	−.1099	−.0189	−.2217	−.2406
Products per Therapeutic Substitute Molecule	1.7655	.5210	−.2205	.1545	.2744	.0805	.3549
Therapeutic Substitute Molecule Entry Lag	3.4977	3.5399	−.0274	.0792	−.0012	.2802	.2791
Competition subtotal					2.0954	2.5499	4.6453
Therapeutic categories:							
A	.0640	.0827	−1.5257	.9184	−.0285	.0760	.0474
B	.0325	.0602	−1.0976	.5072	−.0303	.0305	.0002
D	.0661	.0752	−.8847	.5348	−.0080	.0402	.0322
G	.0294	.0326	−.1697	.6142	−.0005	.0200	.0195
H	.0315	.0627	.1930	.6496	.0060	.0407	.0467
J	.1333	.1228	.6287	−.5203	−.0066	−.0639	−.0705
L	.0032	.0201	.2888	...	.0049	...	.0049
M	.0724	.0952	.2614	−.4031	.0060	−.0384	−.0324
N	.2833	.1779	−.2660	−.5398	.0280	−.0961	−.0680
P	.0021	.0025	−.3125	−2.1418	−.0001	−.0054	−.0055
R	.0682	.0777	.5957	...	.0057	...	.0057
S	.0089	.0025	−3.0996	...	.0199	...	.0199
Therapeutic categories subtotal					−.0037	.0037	−.0000
Residual intercept	1.0000	1.0000	4.9894	−1.3633	.0000	−1.3633	−1.3633
Residual subtotal					.0000	−1.3633	−1.3633
Total: log of observed price ratios							.6619

VII. Conclusions

This study has used comprehensive IMS data for seven countries for 1992 to estimate the effect of competition on drug prices at the level of the individual product, controlling for other relevant characteristics such as molecule age, strength per dose, pack size, and so on. Consistent with expectations, we find a steeper decline of price with molecule age in regulated markets. Generic competition has a significant negative effect on price for the United States and other countries with relatively free pricing (the United

Kingdom, Germany, and Canada), whereas for the countries with strict price regulation (France, Italy, and Japan), the number of generic competitors has either no effect or a positive effect on prices. This is consistent with anecdotal evidence that in countries with strict regulation, generic competitors are predominantly either licensed co-marketers or ''new'' versions of old molecules that manufacturers introduce in order to obtain a price increase. By contrast, in countries with free pricing, successive generics enter at lower prices, and prices at the product and molecule levels are inversely related to the number of generics. Competition through volume discounts on large packs is an important generic strategy in the United States and other less regulated markets but is undermined by regulation of retail pharmacy, including unit pack dispensing requirements, in France, Germany, and Italy.

There is therapeutic competition in the form of lower prices for successive entrants in unregulated markets. Controlling for this, the number of Therapeutic Substitute Molecules does not appear to reduce prices except in Italy and Japan, where the effect is more consistent with the design of their regulatory systems than with competition. The estimates for therapeutic competition are almost certainly biased by endogeneity, unobserved promotional expense, and unobserved discounts in the United States, for which our data cannot control. The point estimate of the net effect of therapeutic substitutes, including the number of substitute molecules, products per substitute molecule, and substitute molecule entry lag, is more negative for the United States than for all other countries except Japan.

It might appear from this analysis that regulatory pressure on prices over the product life cycle achieves roughly the same effect as generic competition in less regulated markets. However, it would be incorrect to conclude that the net welfare effect is the same. The analysis here examines effects of regulation and competition on individual product prices at the manufacturer level. Our data do not reflect effects at the level of retail prices paid by final consumers or third-party payers. Competition in retail pharmacy is likely to pass on the savings in manufacturer prices to final consumers, whereas there is no such presumption when retail pharmacy is regulated to restrict price competition. Moreover, the benefits of competition in retail pharmacy extend beyond the level of prices for medicines included in this analysis and include effects on prices of other OTC and consumer products sold through retail pharmacy, as well as convenience and other nonprice benefits of competition. These findings suggest that regulation of both manufacturer prices and retail pharmacy undermines competition in the off-patent sector and that the potential budgetary savings from postpatent competition are not fully realized in countries with strict regulatory systems.

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