Prices And Availability Of Pharmaceuticals: Evidence From Nine Countries

The U.S. market structure, with its higher prices for on-patent products and strong generic competition, appears more favorable to innovation than markets elsewhere.

by Patricia M. Danzon and Michael F. Furukawa

ABSTRACT: This study compares average price levels for pharmaceuticals in eight countries—Canada, Chile, France, Germany, Italy, Japan, Mexico, and the United Kingdom—relative to the United States. Our most comprehensive indexes, adjusted for U.S. manufacturer discounts, show Japan's prices to be higher than U.S. prices, and other countries' prices ranging from 6 percent to 33 percent lower than U.S. prices. The decline of the Canadian dollar and rise of the U.K. pound contribute to the finding of lower Canadian prices and higher U.K. prices in 1999 than in 1992. Our findings suggest that U.S.–foreign price differentials are roughly in line with income and smaller for drugs than for other medical services.

CROSS-NATIONAL DIFFERENCES in pharmaceutical prices are of great interest around the world. Reports of U.S. senior citizens making bus trips to Canada to buy prescription drugs, together with the conclusions of several previous price-comparison studies, suggest that drug prices are much higher in the United States than in other countries.[1] However, most previous studies are based on a few widely used brand-name drugs and omit all generics, even though generics now account for roughly half of unit volume in the United States.[2] This paper provides more representative comparisons of drug prices in eight countries—Canada, Chile, France, Germany, Italy, Japan, Mexico, and the United Kingdom—with U.S. prices. Such comprehensive comparisons are essential to obtaining more accurate measures of overall price differences and to understanding the effects of each country's regulatory and competitive environment. To this end, we also compare use as well as prices. Price comparisons are reported separately for originator, generic, and over-the-counter (OTC) products, to illustrate the bias that results from focusing solely on originator products. We also show the effects of exchange-rate movement, of converting currencies at purchasing power parities (PPPs) rather than exchange rates, and of adjusting for income.

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Providing accurate international drug price comparisons is not straightforward, because each country's pharmaceutical market basket is different. Products that are identical across countries in presentation form, strength, pack size, and manufacturer account for a tiny fraction of each country's total sales. This implies a trade-off: Comparisons that are restricted to identical products in all countries are severely unrepresentative. Applying less strict matching requirements enables more representative comparisons but with some loss of standardization. Consequently, there is no unique, correct measure of price differences; rather, conclusions depend on unavoidable judgments about sample selection, matching criteria, the measure of price, and the weights attached to individual products in the composite index. Here we report several comparisons to illustrate the sensitivity of results to these methodological choices.

An earlier study used a fully comprehensive database of 1992 prices and concluded that for the U.S. market basket of drugs, U.S. prices were on average comparable to those in Canada, lower than those in Germany and Japan, and higher than those in the United Kingdom, France, and Italy.[3] The new study we report on here uses 1999 data. An important question is, How did relative drug prices change in the 1990s? The results we report provide bottom-line conclusions and some evidence on contributing factors.[4]

Study Data And Methods

Our data are from the IMS Health Midas data set.[5] Most of our analysis is at manufacturer-price levels, excluding wholesaler and pharmacy markups. Because IMS data for the United States do not reflect off-invoice manufacturer discounts given to managed care and government buyers, we estimate these discounts and report most of our results net of discounts, to provide a more accurate measure of net manufacturer prices.

Standard price index methods require a representative sample of products from each country, but prices can only be compared for matching products, which, for pharmaceuticals, might not be representative of each country's market.[6] For this study we started with the 350 leading molecules (active ingredients) by U.S. unit (dose) sales volume in 1999, to approximate the most frequently used molecules. From these 350 molecules we selected 249, focusing on those that were available in at least four of our study countries in 1992 and including most new chemical entities (NCEs) approved in the United States since 1992. Our comparison countries include the four largest European markets that are referenced by Canada (Sweden and Switzerland were excluded because of small market size), plus Japan (the second-largest market), Canada and Mexico (which are frequently compared to the United States), and Chile as a second Latin American country.[7] For each molecule, we include all products with that active ingredient, including brand-name, generic, and OTC products (if available), and all presentations (capsules, tablets, and so on) and strengths in each country. This sample should thus be reasonably

representative of U.S. outpatient pharmaceutical sales, possibly with disproportionate representation of new products and internationally diffused products. The sample represents 30–60 percent of sales in the nine countries (Exhibit 1).[8] It is more comprehensive, in number of compounds and presentations, than most previous comparisons. The market basket for each bilateral U.S.–foreign comparison includes all matching molecules that are available in both countries.

Most previous price comparisons compare single, identical packs with the same manufacturer, active ingredient (molecule), presentation, strength, and sometimes pack size. These strict matching requirements exclude most licensed products and most generics, thereby restricting the analysis to originator products that are marketed internationally by multinational companies. Such comparisons are seriously unrepresentative, particularly for countries with widespread penetration of generics, including the United States, Canada, Germany, and the United Kingdom.

Our main unit of analysis is the molecule-indication, defined by active ingredient and the IMS three-digit anatomical therapeutic class. Thus, each country's bilateral comparison with the United States includes all molecule-indications that match between that country and the United States. A country's price per dose for a molecule-indication is its volume-weighted average price per dose over all presentations in that molecule-indication in that country.[9] Measuring price per dose for a molecule-indication rather than a pack enabled us to include all presentations of each compound in each country, including those that differ in formulation or manufacturer between the United States and the comparison country. Thus, except where explicitly stated, we include originator and generic products and

EXHIBIT 1
Pharmaceutical Market Structure In Nine Countries: Sample Of 249 Leading U.S. Molecules, By Volume, 1999

	Canada	Chile	France	Germany	Italy	Japan	Mexico	U.K.	U.S.
Total outpatient sales[a]	$4,402	$559	$14,481	$16,213	$9,498	$22,002	$3,545	$8,647	$103,134
Sample percent of sales	61%	33%	37%	35%	42%	31%	33%	62%	61%
Matched by mol-indication	56%	30%	33%	32%	39%	27%	31%	57%	
Matched by mol-presentation	35%	14%	17%	15%	21%	10%	16%	33%	
Number of molecules	236	223	228	241	228	189	225	243	249
Availability of U.S. molecules	95%	90%	92%	97%	92%	76%	90%	98%	100%
Indications per molecule	1.4	1.3	1.3	1.5	1.4	1.3	1.3	1.4	1.5
Percent multisource mol-indications[b]	73%	75%	52%	69%	64%	70%	63%	62%	70%
Number of presentations[c]	1,354	943	989	1,964	1,124	938	922	1,451	2,196
Manufacturers									
Per form	2.3	2.4	1.7	4.5	2.0	3.5	1.9	1.7	4.9
Per multisource form	6.5	6.3	5.1	16.5	5.5	11.3	5.1	5.6	18.6

SOURCE: Authors' calculations based on data from the IMS Health Midas data set, 1999.

[a] Millions of U.S. dollars.

[b] Generic available.

[c] Molecule-indication-form-strength.

OTC forms. Of course, this broad measure results in some loss of standardization and could lead to bias, for example, if one country systematically has more costly forms—say, enteric coated versus uncoated tablets or higher-strength doses on average. We also report some results restricting the comparison to presentations that match on form and strength (still ignoring pack size and manufacturer). This drastically reduces the fraction of each country's sales that can be included (see Exhibit 1) and can lead to systematically biased conclusions.

Whereas several previous studies compare drug prices at the retail pharmacy level, we focus on manufacturer prices, thus eliminating differentials attributable to wholesaler and retailer margins and taxes. In contrast to prior comparisons, we adjust for manufacturer discounts to managed care and Medicaid, to eliminate the upward bias in U.S. prices that results if these discounts are ignored.[10] Manufacturer discounting to retail pharmacies is also common in the United Kingdom. The IMS data include an estimate of the U.K. discounts, and we make no further adjustment because we lack the necessary data.[11]

Any international price comparison invites the question of which country's consumption should be used to weight the individual products in a composite index. Our indexes here reflect U.S. volume weights for each molecule-indication, since our primary interest is in the cost of the U.S. market basket at foreign prices.[12] We use prevailing (1999) exchange rates to convert foreign currencies to U.S. dollars, except where explicitly noted otherwise.

A total of 575 presentations were excluded from the analysis because they had implausible values.[13] These outliers could reflect data-reporting error or inconsistent reporting across countries, particularly for specialty packs such as nasal sprays, creams, and so on.

Comparison Of Product Availability And Market Structure

Exhibit 1 illustrates the diversity of pharmaceutical markets across countries. Of our 249 molecules, at least 90 percent are available in all countries except Japan, which has only 76 percent of the molecules, despite being second-highest in total sales.[14] Our sample molecules account for 61–62 percent of outpatient sales in the United States, Canada, and the United Kingdom but only 31–42 percent of sales in the other countries. This reflects the other countries' relatively greater consumption of compounds that either are unavailable or have relatively low sales in the United States.

The percentage of molecules that are multisource (that is, that have at least one generic producer) ranges from 52 percent in France, where post-patent generic entry is slow or nonexistent, to 75 percent in Chile, where copy products may enter before patent expiration. The number of manufacturers (including repackagers) per product and, in particular, per multisource product, is highest in the United States and Germany, as is the number of presentations. The range of presentations and strengths per molecule provides some indication of competi-

tion by product mix to achieve a higher price or higher sales in both regulated and unregulated markets. Opinions differ as to which new formulations add real value—for example, controlled-release formulations might improve convenience and compliance for at least some patients.

■ **Originator versus generic products.** In previous research we found that countries with strict price regulation have lower generic penetration than less regulated markets, because regulation tends to drive out competition.[15] Similarly in this sample, total generic share of unit volume is low in the price-regulated markets of France (28 percent), Italy (34 percent), and Japan (40 percent), and higher in countries with freer pricing such as the United States (58 percent), Germany (61 percent), and the United Kingdom (49 percent) (Exhibit 2). Canada's high generic share (59 percent), despite price controls on originator products, reflects Canada's other policies to encourage use of generics, including compulsory licensing policies until the early 1990s and incentives for pharmacists to substitute generics.

Within the generic sector, brand-name generics compete partly on brand image, whereas unbranded generics compete primarily on price. Thus, in the United States, where the generic sector is dominated by unbranded products, total generic share is 58 percent of units but only 18 percent of sales, reflecting relatively low generic prices. By contrast, in Germany, where most generics are branded, generic share is 61 percent of units but 34 percent of sales, reflecting relatively higher generic prices. In France, which has strict price regulation, unbranded generics are only 7 percent of units and 3 percent of sales.

Exhibit 2 also distinguishes between single-source originator (no generic competitors) and multisource originator products (with generic competitors and presumably off patent). In countries with strong generic competition, the volume share of originator multisource products is low, reflecting originators' post-patent

EXHIBIT 2
Originator And Generic Shares Of Unit Volume And Dollar Sales In Nine Countries, Sample Of 249 Leading U.S. Molecules, 1999

Percent of unit volume	Canada	Chile	France	Germany	Italy	Japan	Mexico	U.K.	U.S.
Originator									
Single source	19%	4%	36%	15%	33%	29%	18%	16%	28%
Multisource	22	13	36	24	33	31	45	35	14
Generic									
Brand-name	30	26	21	43	32	32	30	12	14
Unbranded	29	57	7	18	2	8	6	37	44
Percent of sales									
Originator									
Single source	54	13	67	40	50	57	25	54	70
Multisource	21	25	20	26	29	25	49	24	13
Generic									
Brand-name	13	42	11	25	20	16	24	11	8
Unbranded	13	20	3	9	1	2	2	12	10

SOURCE: Authors' calculations based on data from the IMS Health Midas data set, 1999.

loss of share to generics. The United States has the second-lowest originator multisource share (14 percent) (Chile has the lowest). The multisource originator share, by contrast, is 33–36 percent in the regulated markets of France and Italy, while generic shares are negligibly small. Thus, in price-regulated markets, originator products may receive lower prices while on patent, but they can better defend their markets after patent expiry because generic competition is weak.

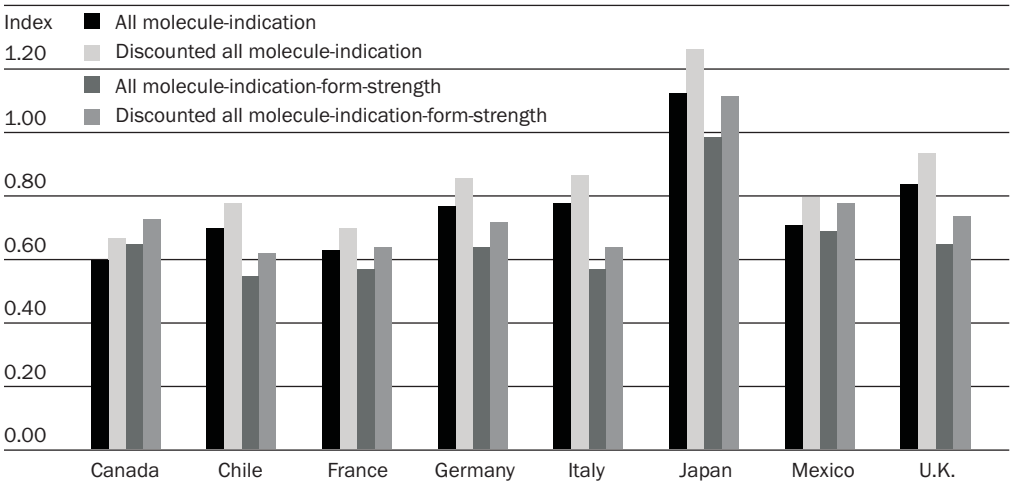
Overall Price Indexes

Exhibit 3 reports four price indexes for each country, to illustrate the effects of strict product matching and of U.S. discounts. For each country the first two indexes include all products in each molecule-indication, regardless of presentation or strength, while the third and fourth indexes restrict the comparison to presentations that match on indication, form, and strength. Within each pair the first index is undiscounted, and the second includes our adjustment for discounts. All indexes include brands and generics, and OTC products, if any. Index values less (greater) than 1.00 imply foreign prices lower (higher) than U.S. prices.

Our estimated adjustment for off-invoice discounts reduces U.S. prices by roughly 8 percent overall, which is comparable to other estimates.[16] The discount adjustment differs slightly across countries depending on the product mix, because our estimated discounts differ across products, depending on each product's payer mix (pharmacy benefit manager, or PBM; Medicaid; cash), mail-order share, and originator versus generic mix.

By these most comprehensive indexes, Japan's drug prices are highest, followed

EXHIBIT 3
Price Indexes: Matching On Molecule-Indication Versus Molecule-Indication-Form-Strength, Without And With Adjustment For U.S. Manufacturer Discounts, Manufacturer Prices In Eight Countries Relative To U.S. Prices, 1999



SOURCE: Authors' calculations based on data from the IMS Health Midas data set, 1999.
NOTE: United States equals 1.00.

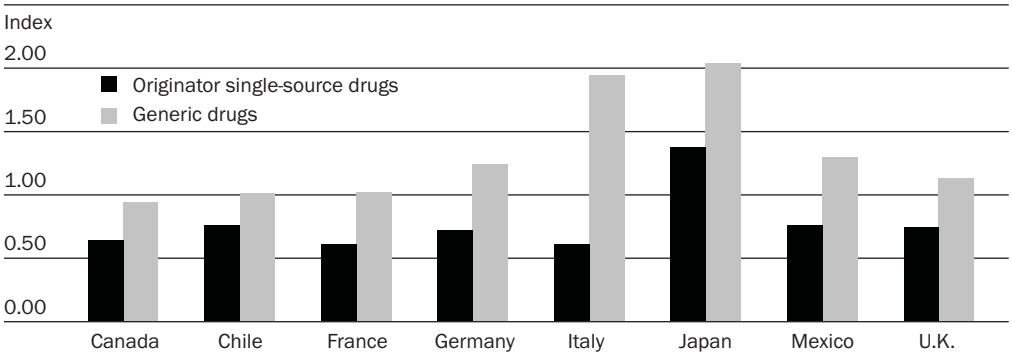
by U.S. prices. Canada's prices are lowest: 33 percent lower than U.S. prices net of discounts, and 40 percent lower ignoring discounts. Prices in Germany, Italy, and the United Kingdom are less than 15 percent lower than U.S. prices, net of discounts, whereas prices in France are 30 percent lower.[17] These U.K. comparisons could be biased, depending on the accuracy of the IMS estimate of discounting to U.K. pharmacists.[18] Despite their lower per capita income, Mexico and Chile appear to have prices comparable to those in some European countries.

Restricting the comparisons to presentations that are identical in form and strength provides a stricter apples-to-apples comparison, but at the cost of reducing the sample size by about half (Exhibit 1), yielding comparisons that are based on only 10–21 percent of sales in all countries except Canada and the United Kingdom. For this very restricted sample, U.S. prices adjusted for discounts are still second-highest, after Japanese prices, and most countries (except Canada) appear lower relative to the United States. For example, the United Kingdom drops twenty percentage points and Germany, fourteen percentage points. This evidence that most other countries appear cheaper, relative to the United States, when comparisons are restricted to identical presentations implies that previous price comparisons that include only one—usually tablet—presentation of each product are likely to yield upward-biased estimates of U.S. prices relative to prices elsewhere.

Factors Contributing To Overall Price Differences

■ **Originator versus generic prices and market shares.** Exhibit 4 reports price comparisons for single-source originator products (a proxy for on-patent brands) and generics.[19] For on-patent originator products, Japan is still the highest, and U.S. prices appear higher, relative to other countries, than with the comprehen-

EXHIBIT 4
Price Indexes: On-Patent Brand-Name Drugs (Originator, Single-Source) Versus Generic Drugs, Manufacturer Prices In Eight Countries Relative To U.S. Prices, Adjusted For U.S. Discounts, 1999



SOURCE: Authors' calculations based on data from the IMS Health Midas data set, 1999.
NOTE: United States equals 1.00.

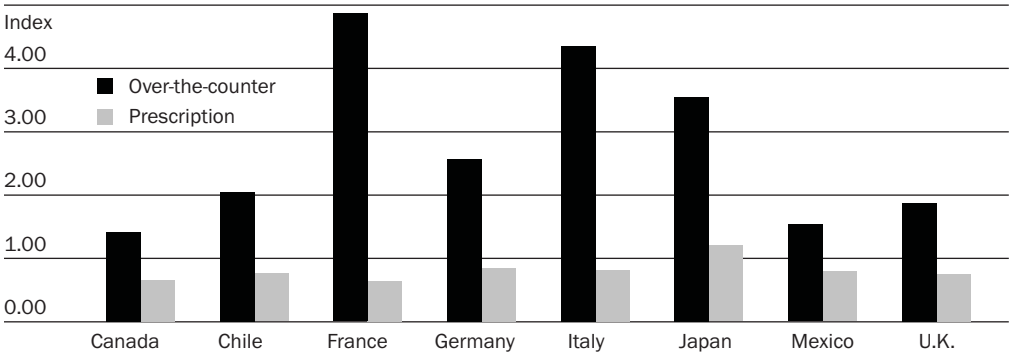
sive sample including generics in Exhibit 3. For on-patent originator products, France and Italy have the lowest prices (0.61), followed by Canada (0.64), and the United Kingdom drops dramatically, from 0.94 to 0.74. If we restrict the brand comparison to presentations that match on form and strength, Japan is still the highest (1.05), but all other countries are 28–42 percent lower than the United States.

In contrast to on-patent originators, generic prices are lower in the United States than in all other countries except Canada, where generic prices are 6 percent lower than U.S. generic prices. Since generics in the United States account for a relatively large share (Exhibit 2) and have relatively low prices compared with most other countries, omitting generics from price comparisons leads to seriously upward-biased estimates of average U.S. prices for the U.S. pharmaceutical market basket. Specifically, if the comparison is restricted to strictly matching presentations of on-patent originator products, as in most comparisons, most countries appear 28–42 percent lower than the United States, whereas our comprehensive indexes in Exhibit 3 show smaller differentials, with most countries 6–30 percent lower than the United States.

■ **OTC prices and market shares.** Exhibit 5 compares prices for products that are OTC in the United States. The matching products in the comparison countries could be either on prescription or OTC, because samples are too small to require OTC status in both countries. Conclusions are tentative because of the small sample. Nevertheless, the data strongly suggest that OTC products in the United States are considerably cheaper than comparable products in all comparison countries. Higher OTC prices in comparison countries than in the United States reflect these countries' more regulated and less competitive pharmacy markets, including, in some countries, retail price maintenance on OTC products.

■ **Exchange-rate movements.** Exchange rates play a critical role in cross-national price differences. For example, if a drug were launched at the same price in

EXHIBIT 5
Price Indexes: Over-The-Counter Versus Prescription Drugs, Manufacturer Prices In Eight Countries Relative To U.S. Prices, Adjusted For U.S. Discounts, 1999

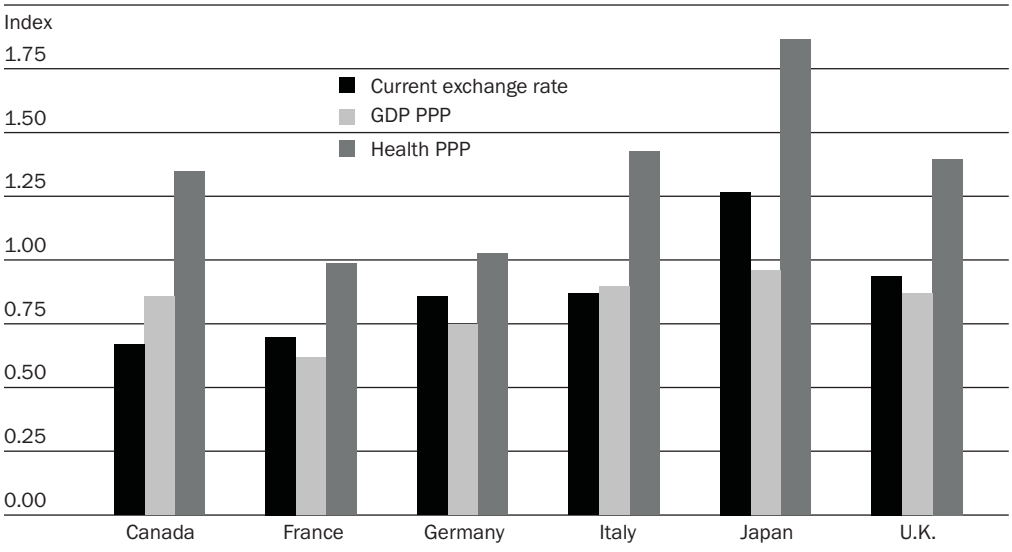


SOURCE: Authors' calculations based on data from the IMS Health Midas data set, 1999.
NOTE: United States equals 1.00.

the United States and Canada in 1990, a decline in the value of the Canadian dollar relative to the U.S. dollar would make the Canadian drug appear cheaper in U.S. dollar terms in 2000, even if local currency prices had remained constant in both countries. To calculate the effect of postlaunch exchange-rate movement, we estimated price indexes using each molecule's exchange rate at launch. These indexes measure the price differences that would have existed in 1999, had exchange rates remained at the levels that prevailed when each compound was launched. Netting out exchange rate movements, Canadian prices are only 14 percent lower than U.S. prices. Thus, with our sample, the decline in the Canadian dollar during the 1990s contributed nineteen percentage points of the overall 33 percent price differential at current exchange rates. Conversely, the appreciation of the U.K. pound contributed greatly to the estimate of higher U.K. prices in 1999 than in 1992, relative to the United States.

■ **Exchange rates versus PPPs for GDP and health services.** Exhibit 6 shows the effect of converting foreign currencies to U.S. dollars using PPPs based on total gross domestic product (GDP) and the health PPPs from the Organization for Economic Cooperation and Development (OECD).[20] GDP PPPs are rates of currency conversion that equalize the purchasing power of different currencies for an economywide basket of goods, whereas health PPPs measure the relative cost of a basket of medical goods and services. Using GDP PPPs, Canada's drug prices are

EXHIBIT 6
Current Exchange Rates Versus Gross Domestic Product (GDP) And Health Purchasing Power Parities (PPPs), Manufacturer Prices Adjusted For U.S. Discounts, Six Countries Relative To U.S. Prices, 1999



SOURCE: Authors' calculations based on data from the IMS Health Midas data set, 1999. PPPs are from Organization for Economic Cooperation and Development, *OECD Health Data 2000* (Paris: OECD, 2000).
NOTE: United States equals 1.00.

only 14 percent below U.S. levels but 33 percent lower using exchange rates; conversely, with GDP PPPs, Japan drops from 1.27 to 0.96, and the United Kingdom drops from 0.94 to 0.87. These results further demonstrate how exchange rates can affect measured price differentials.

By contrast, when we use health PPPs, all countries appear to have higher drug prices than the United States, except France, which is at par (0.99). This striking result implies that other countries' prices for medical services other than drugs are even lower, relative to U.S. prices, than their prices for drugs. The health PPPs are approximate, because although they purport to price a common basket of medical services in all countries, many items, such as a hospital admission or physician visit, represent very different services in different countries. With this caveat, the health PPPs indicate that within the basket of medical services, U.S. relative prices for drugs are lower than relative prices for other medical services.

■ **Retail prices versus manufacturers' prices.** Some previous price comparisons have compared retail (public) prices to final customers rather than manufacturers' prices to wholesalers. Although public prices are a valid concern, the causes of observed differences are more complex because retail prices reflect wholesale and pharmacy markups and possibly value-added taxes, in addition to manufacturer prices.

Our comparisons of public prices using IMS data are tentative, because the IMS estimates of retail margins are approximate and because we lack the data to adjust for discounts on distribution margins in the United States and some other countries. Nevertheless, the general conclusion from these retail-price comparisons is that retail prices in the European countries that regulate pharmacy margins (France, Germany, and Italy) are much higher, relative to U.S. prices, than their manufacturer prices; hence, differences measured at retail prices are smaller than differences at manufacturer prices. This conclusion would be true a fortiori if U.S. retail prices were adjusted for managed care discounts on pharmacy margins.

In fact, high regulated wholesale and retail pharmacy distribution margins in some foreign countries could contribute to their lower manufacturer prices, if payers are concerned about their total drug budget and negotiate their manufacturer prices based on the implied public price minus distribution margins. In other words, countries that regulate drug prices and distribution margins tend to allocate a larger fraction of their total drug spending to distribution and less to manufacturer prices for drugs.

■ **Dispersion of relative prices.** We found wide variation in the relative prices for different compounds and presentations of the same compound in a given U.S.–foreign comparison. Thus, the effect of price regulation in, say, France is not simply to reduce all French prices by a uniform percentage relative to unregulated U.S. prices. This is a further reason why valid price comparisons must be based on large samples and why comparisons based on a single pack can be seriously biased.

Drug Use Per Capita

A detailed analysis of differences in drug availability and use is reported elsewhere.[21] As a rough summary measure, Exhibit 7 shows each country's per capita consumption, relative to the U.S., for drugs in each molecule age category. (Each molecule's age is measured in months from its first launch in any country to June 1999. For example, a molecule that was first launched in January 1998 would be eighteen months old in June 1999.) Since our sample was selected from leading products in the United States, one might expect that U.S. consumption of these molecules would be higher than in other countries. In fact, aggregating over our sample compounds, total per capita consumption is similar to that in the United States in Canada, France, and the United Kingdom (Exhibit 7).

However, for compounds launched in the most recent two years (age twenty-four months or less), all countries except Germany have 50 percent lower consumption than the United States has; for molecules launched within the prior five years, all countries except France, Canada, and Germany have at least 50 percent lower consumption per capita than the United States has. By contrast, for molecules more than ten years old, which are predominantly off-patent molecules, Canada, France, and the United Kingdom have comparable consumption to that of the United States.[22] The relatively low per capita consumption of new molecules in other countries than in the United States reflects both longer launch lags and low utilization conditional on launch. Launch lags have been particularly severe in Japan.[23]

By contrast, Mexico's per capita consumption of our sample compounds is only 12 percent of U.S. consumption, and 6 percent or less for molecules launched within the past ten years. Chile's per capita consumption is 22 percent of U.S. levels overall, but 8 percent or less for molecules under ten years old. Thus, these two countries' lower per capita incomes, compared to the other countries in the sample, are reflected far more in lower volumes, especially for new products, than in lower prices. Unfortunately, there could be a causal relationship: Their low volumes could be an inevitable response to high prices relative to their per capita income.

EXHIBIT 7
Per Capita Consumption Of 249 Leading U.S. Molecules, By Molecule Age, Relative To U.S. Consumption, 1999

Molecule age	Canada	Chile	France	Germany	Italy	Japan	Mexico	U.K.
24 months or less	26	2	44	58	25	1	4	32
25–60 months	65	6	91	72	44	5	3	42
61–120 months	99	8	101	60	76	52	6	90
121 months or more	94	25	100	82	62	57	13	125
Total	91	22	97	78	62	53	12	115

SOURCE: Authors' calculations based on data from the IMS Health Midas data set, 1999.
NOTE: United States equals 100.

"Drug price differentials between countries roughly reflect income differences (except for Chile and Mexico)."

There are several caveats to these comparisons of drug consumption. First, these data show use of our sample compounds only, not differences in total per capita drug consumption. Second, because the sample selection focused on leading U.S. products and products recently launched in the United States, it could appear biased toward new drugs launched in the United States. However, the number of recent molecules is similar in most countries, except Japan and Italy. Rather, conditional on launch, the newer molecules are more widely used, absolutely and in proportion to total drug consumption, in the United States than in most other countries. Moreover, since our sample molecules account for a larger share of total consumption in the United States than in other countries, the differential in these new molecules' share would be even greater if measured as a percentage of each country's total drug consumption. Finally, this comparison of total units obscures differences in formulations, which are discussed elsewhere.[24]

Discussion And Conclusions

Pharmaceutical market structure differs greatly across countries, in range of compounds, presentations, use, generic shares, and number and type of manufacturers. This diversity implies that no single perfect price comparison is feasible. Nevertheless, our indexes based on broadly representative samples are more accurate than comparisons based only on small numbers of originator products. Such comparisons, often using retail prices that include distribution markups, without adjustment for U.S. discounts, provide a very misleading picture of overall average differences in prices charged by manufacturers.

Our most comprehensive indexes show Japan's prices to be higher than U.S. prices, other countries' prices ranging 6–33 percent lower than U.S. prices, and Canadian prices to be the lowest. Exchange rates contribute greatly to measured price differences, as discussed above, especially regarding comparisons with Canada, the United Kingdom, and the United States. However, none of these estimates reflects the recent decline of the U.S. dollar, which could change price differentials measured in 2003, even if prices in local currencies had remained unchanged.

Converting foreign currencies at GDP PPPs (which standardize for cost-of-living differences) rather than exchange rates essentially eliminates the Japan–U.S. price differential and reduces the Canada–U.S. price differential from 33 percent to 14 percent. Converting using health PPPs shows drug prices higher, relative to U.S. prices, in all countries except France (data were unavailable for Mexico and Chile). Since health PPPs are, in principle, defined to equalize the cost of a basket of medical goods and services across countries, they should yield drug price indexes of one, if drug price differentials were similar to medical price differ-

entials. Our finding that using health PPPs, foreign drug prices exceed U.S. prices implies that U.S.–foreign price differentials are smaller for drugs than for other medical services.

Cross-national price differentials are not confined to pharmaceuticals. For example, a recent European Union (EU) survey found price differentials of consumer electronics and food items often exceeding 50–100 percent among the EU countries.[25] Contributing factors plausibly differ across industries. Although a full analysis of factors leading to price differentials for drugs and other medical services is not possible here, income is clearly one factor (Exhibit 8). At 1999 exchange rates, per capita income was higher in the United States than all of our comparison countries except Japan. In fact, when we normalize the price differentials by the income differentials, foreign–U.S. drug price differentials become positive for all countries except France and are generally smaller, which suggests that price differentials are correlated with income differentials. The major exceptions are Mexico and Chile, whose price differentials are more than five times their income differentials. Granted, our sample represents only 33 percent of these countries' drug spending and might not be representative of prices for the omitted drugs. Nevertheless, the dramatically lower per capita consumption of our sample drugs in Mexico and Chile than in the higher-income countries confirms that these drugs are unaffordable to most people.

Income differentials contribute to price differentials both directly and indirectly. The direct effect reflects the cost of labor, which is significant for many medical services. The indirect effect reflects the effect of income on product mix and prices, through consumers' ability and willingness to pay for higher-quality, more convenient goods and services. Some of the supposedly higher U.S. prices for hospital days and physician visits reflects greater capital and skilled-labor intensity and consequently differences in services performed, which is imperfectly controlled for in price comparisons. Capital regulation in many countries no doubt

EXHIBIT 8
Price And Volume Indexes, Relative To Per Capita Income, In Nine Countries, Sample Of 249 Leading U.S. Molecules, 1999

	Canada	Chile	France	Germany	Italy	Japan	Mexico	U.K.	U.S.
GDP per capita	$21,306	$4,864	$24,628	$25,624	$20,487	$35,479	$4,976	$24,874	$33,038
GDP normalized to U.S.	64	15	75	78	62	107	15	75	100
Price index (molecule-indication)	0.67	0.78	0.70	0.86	0.87	127	0.80	0.94	100
Price index normalized by income	104	528	93	110	141	118	529	125	100
Volume (total doses) per capita normalized to U.S.	93	23	100	79	63	54	12	118	100
Volume normalized by income	144	154	134	102	101	50	82	157	100

SOURCE: Authors' calculations based on data from the IMS Health Midas data set, 1999.
NOTE: GDP is gross domestic product.

also contributes to differences in capital intensity that in turn contribute to (mis)measured medical price differences.

Our finding that drug price differentials between countries roughly reflect income differences (except for Chile and Mexico) plausibly reflects the interaction of drug manufacturers' pricing strategies, using income as a rough proxy for demand elasticities, and regulation. Such price differentials would be inappropriate for products that are perfectly competitively supplied and are subject to free trade, for which prices should approximate marginal cost. However, research-based pharmaceuticals entail sizable fixed costs of research and development (R&D), which must be recouped if R&D is to continue. The purpose of patents is to enable pricing above marginal cost in order to recoup R&D costs. This pharmaceutical R&D is a "global joint" cost—that is, once incurred, it can benefit consumers worldwide, with only relatively modest marginal costs of production. The dilemma is, How should the joint costs of R&D be allocated across countries? The economic answer to this question is that if the objective is to maximize social welfare, then the global joint costs should be recouped through price markups over marginal cost that differ based on income levels, assuming that income is a major determinant of "true" price elasticity.[26] Thus, price differentials that are related to income would be consistent with both economic efficiency and equity. Our evidence of relatively low per capita drug consumption in Mexico and Chile illustrates the potential welfare loss from reduced use when drug prices are out of line with incomes.

In practice, of course, systems of drug price regulation, reimbursement, and competition also contribute to international price differences. The decline in Canadian prices relative to U.S. prices, after exchange-rate movement is controlled for, plausibly reflects Canada's federal price regulation and provincial formularies. The tendency for U.S. policymakers to compare U.S. prices to Mexican prices and the threat of importation plausibly makes manufacturers reluctant to offer prices in Mexico that are more in line with that country's average per capita income.

Overall, the relatively unregulated, more competitive structure of the U.S. market seems to result in relatively high prices for on-patent originator products and relatively high use of new products, but strong generic competition, high generic shares and low generic prices once patents expire, and a relatively large share of the total public price that goes to manufacturers rather than to intermediaries. By contrast, more regulated markets have lower originator prices but larger post-patent sales for originators and less generic competition. The U.S. structure appears more favorable to innovation. How far it has contributed to the U.S. pharmaceutical industry's superior performance in developing new compounds is beyond the scope of this paper.

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NOTES

1. The U.S. General Accounting Office concluded that U.S. prices were 32 percent and 60 percent higher than prices in Canada and the United Kingdom, respectively. U.S. General Accounting Office, *Prescription Drugs: Companies Typically Charge More in the United States than in Canada*, Pub. no. GAO-HRD-92-110 (Washington: GAO, 1992); and GAO, *Prescription Drugs: Companies Typically Charge More in the United States than in the United Kingdom*, Pub. no. GAO/HEHS-94-29 (Washington: GAO, 1994). A more recent study reported that U.S. drug prices were 70 percent higher than prices in Canada and 102 percent higher than prices in Mexico. U.S. House of Representatives, Committee on Government Reform and Oversight, *Prescription Drug Pricing in the First Congressional District in Maine: An International Price Comparison*, Minority Staff Report (Washington: U.S. House of Representatives, 24 October 1998).
2. See Exhibit 2.
3. P.M. Danzon and L.W. Chao, "Cross-National Price Differences for Pharmaceuticals: How Large and Why?" *Journal of Health Economics* (March 2000): 159–195.
4. For more comprehensive analysis, see P.M. Danzon and M.F. Furukawa, "Prices and Availability of Pharmaceuticals in Nine Countries: Evidence and Analysis" (Working paper, forthcoming).
5. IMS Health, a market research company based in Plymouth Meeting, Pennsylvania, is a leading provider of pharmaceutical and health care information. The IMS Midas database reports pharmaceutical sales in more than seventy countries, based on audits of retail pharmacies and other channels.
6. Our 1992 database included all drug sales in nine countries (Canada, France, Germany, Italy, Japan, Sweden, Switzerland, United Kingdom, and United States). Sweden and Switzerland were excluded from most analyses because they had relatively few molecules. In that 1992 study, despite starting with the universe of sales, only 171 molecules were available in all seven countries, whereas 350–425 molecules were available in each country matched bilaterally with the United States. These U.S.-matched molecules accounted for less than half of all molecules available in France, Germany, Italy, and Japan in 1992.
7. Canada caps its prices for innovative drugs to the median price of the same drug in seven countries: France, Germany, Italy, Sweden, Switzerland, United Kingdom, and United States.
8. Our U.S. data omit mail-order sales, which account for about 12 percent of total U.S. sales. Our discounted indexes include the estimated discount on mail-order sales. We exclude combination products because ingredient mix is not standardized across countries. We exclude hospital sales because price discounting is common for hospital sales; hence, IMS data are less accurate for hospital prices.
9. For each product/presentation, IMS defines a standard unit (one tablet, one capsule, 5 ml of a liquid) as a proxy for a dose.
10. Originator manufacturers compete by giving off-invoice discounts to PBMs and health maintenance organizations (HMOs) in return for preferred formulary status, which increases market share. For originator products, Medicaid requires a discount of 15.1 percent or the "best price" given to any nonfederal purchaser, whichever is greater, plus an "excess inflation" rebate for price increases that exceed the Consumer Price Index (CPI). These confidential discounts are not captured by IMS. For generics, Medicaid requires an 11 percent discount. We estimate an average discount per molecule, based on that molecule's share of sales to each payer type and the estimated average discount by payer type, averaged over the sales channels, and on the generic share of sales within the molecule. See Danzon and Furukawa, "Prices and Availability of Pharmaceuticals in Nine Countries."
11. U.K. pharmacists can substitute parallel imports and, if the prescription is generically written, generics if available. Originator and generic producers give discounts to pharmacists to gain market share.
12. For example, our most comprehensive Canada–U.S. price index includes all molecule-indications that match between the United States and Canada, each weighted by its share of U.S. unit volume. Each country's molecule-indication price is a volume-weighted average of the price for all presentations in that molecule-indication in each country.
13. We excluded presentations based on four screens: less than $1,000 in sales; price per unit more than three standard deviations from the nine-country mean price for that presentation; ratio of foreign to U.S. price greater than 25 or less than 0.04; ratio of foreign to U.S. strength per dose greater than 2 or less than 0.5, where strength per dose is calculated as total grams divided by total doses.
14. Our data underestimate total outpatient sales in Japan, where hospitals provide a sizable share of outpatient care.
15. P.M. Danzon and L.W. Chao, "Does Price Regulation Drive Out Competition in Pharmaceutical Markets?" *Journal of Law and Economics* 43, no. 2 (2000): 311–357. Our generic share refers to unit volume, not prescrip-

tions. For Chile and Mexico, some generics could be copy versions of on-patent products, whereas for other countries with long-standing patent protection, generics reflect post-patent competition.

16. For example, Chris Nee and colleagues estimate that rebates represent 5–10 percent of total drug spending for larger PBMs. L.C. Marsh et al., "Lehman PBM Rebate Call Summary" (New York: Lehman Brothers Global Equity Research, 18 February 2003).
17. Price indexes using price per gram rather than price per dose and weighting by the comparison country's consumption rather than U.S. consumption are reported in Danzon and Furukawa, "Prices and Availability of Pharmaceuticals in Nine Countries."
18. IMS assumes that manufacturer prices in the United Kingdom are 12.5 percent below list prices, whereas the 2001 U.K. Discount Inquiry found an average 10 percent discount (Danny Palnoch, U.K. Department of Health, personal communication, December 2002). We do not have discount percentages for 1999.
19. Our data set does not report patent status, which can differ across countries. Exhibit 4 includes only products that are single-source originator in both the United States and the comparison country.
20. Organization for Economic Cooperation and Development, *OECD Health Data 2000* (Paris: OECD Health Policy Unit, 2000). We were unable to calculate PPP-based indexes for Mexico because our IMS data reported sales for Chile and Mexico only in U.S. dollars, not in local currency units. Thus, we lacked the local currency values to which to apply the PPPs.
21. Danzon and Furukawa, "Prices and Availability of Pharmaceuticals in Nine Countries."
22. The very high U.K. consumption of older compounds reflects a few respiratory products, including inhalers, for which unit measures could be imprecise.
23. P.M. Danzon, R.Y. Wang, and L. Wang, "The Impact of Price Regulation on the Launch of New Drugs," NBER Working Paper no. 9874 (Cambridge, Mass.: National Bureau of Economic Research, 2003).
24. Danzon and Furukawa, "Prices and Availability of Pharmaceuticals in Nine Countries."
25. European Commission, "Price Differences between EU Member States—Results of Commission Surveys," 28 May 2001, www.europa.eu.int/comm/internal_market/en/update/score/scoresurvey.htm (17 October 2003).
26. F.P. Ramsey, "A Contribution to the Theory of Taxation," *Economic Journal* 37 (1927): 47–61; and P.M. Danzon, "Price Discrimination for Pharmaceuticals: Welfare Effects in the U.S. and the EU," *International Journal of the Economics of Business* 4, no. 3 (1997): 301–321.