

Are The Benefits Of Newer Drugs Worth Their Cost? Evidence From The 1996 MEPS

The newer the drug in use, the less spending on nondrug items.

by Frank R. Lichtenberg

ABSTRACT: This study analyzes data on prescribed medicines from the 1996 Medical Expenditure Panel Survey (MEPS) to examine the association between the use of newer medicines and morbidity, mortality, and health spending. We find that people consuming newer drugs were significantly less likely to die by the end of the survey and were significantly less likely to experience work-loss days than were people consuming older drugs. Our most notable finding, however, is that use of newer drugs tends to lower all types of nondrug medical spending, resulting in a substantial net reduction in the total cost of treating a given condition.

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THE NATION'S SPENDING for prescription drugs has grown dramatically, even when general inflation has been controlled for. In 1960 the nation spent around \$70 per person on prescription drugs; that figure had climbed to \$189 by 1980 and reached \$335 by 1998.¹ A recent review of studies on prescription drug spending prepared for the U.S. Department of Health and Human Services (HHS) found that "much of the increase in use and spending has resulted from the introduction of new brand-name drugs, some of which replace existing, less costly treatments and some of which help with conditions for which treatment was not previously available."² This report also notes that "new medications are not simply more costly than older ones. They may be more effective or have fewer side effects; some may treat conditions for which no treatment was available." No studies have examined and attempted to quantify the potential benefits of using newer medications.

We hypothesize that, in general, new drugs within a class or for a given diagnosis are of higher quality than older drugs and that this increase may have a number of impacts, including reduced mortal-

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ity, reduced morbidity, and reduced spending on other medical services, such as inpatient stays and emergency room visits. The hypothesis that drug quality is inversely related to drug age is consistent with the “quality ladder” model of innovation. In this model, according to Gene Grossman and Elhanan Helpman, “innovative goods are better than older products simply because they provide more ‘product services’ in relation to their cost of production.”³

If the quality of new drugs is higher than that of older drugs, the “quality-adjusted price” of new drugs may be lower, even though the unadjusted price is higher. David Cutler and colleagues found that the average cost of treating heart attack patients increased from \$11,175 in 1984 to \$14,772 in 1991.⁴ Most of this increase was attributable to a shift from older treatment regimens (medical management and catheterization) to newer, more expensive regimens (angioplasty and bypass surgery). While mean treatment cost rose at an average annual rate of 4.5 percent, life expectancy following a heart attack increased by eight months—from sixty-two to seventy months—during this period. Cutler and colleagues showed that if the shift to newer treatment regimens were entirely responsible for the increase in life expectancy, and the value of a life-year is \$25,000, then the shift actually reduced the “cost-of-living index” by 1.1 percent per year.

The health economics literature suggests that medical practice variation is pervasive and sizable. If ten doctors saw a patient with a given set of symptoms, conditions, and characteristics, it is highly unlikely that they would prescribe the same medications. Although practice variation may be undesirable from a medical perspective, it is advantageous econometrically, since it facilitates identification of the effect of drug choice on the variables of interest.⁵ In this paper I analyze data on prescribed medicines, linked to data on individual patients and conditions, to provide evidence about the effect of drug age—the number of years since the drug’s active ingredient was first approved by the Food and Drug Administration (FDA)—on mortality, morbidity, and total medical expenditure, controlling for a number of characteristics of the individual and the event.

Data And Methods

Most of the data for this investigation were obtained from the 1996 Medical Expenditure Panel Survey (MEPS), a nationally representative survey of health care use and spending by the U.S. civilian noninstitutionalized population.⁶ The MEPS Household Component collects extremely detailed data from 23,230 people on use of and spending for office and hospital-based care, home health care, and prescribed medicines. MEPS contains data at three different

levels of aggregation: the person level, the condition level (77,000 conditions), and the event level. A person may have several conditions; a given condition may be associated with a number of events.⁷

The unit of observation in our analysis is the prescribed medicine event. The MEPS Prescribed Medicine Event file contains 171,587 observations (Exhibit 1). The file reveals the amount paid for the prescription, by source of payment, and the National Drug Code (NDC), from which we determined (by linking to Mosby's GenRx database and FDA data on new molecular entities, or NMEs) the year in which the active ingredient was first approved by the FDA.

More than 90 percent of the prescriptions are linked to exactly one medical condition.⁸ The MEPS Medical Conditions file contains summary information about these medical conditions, including when it began; whether the person with the condition died by the end of the survey period; whether the person missed any work days or school days or spent any days in bed due to the condition; and the number of hospital, emergency room, outpatient, office-based, dental, and home health events associated with it.

Spending (and charges) associated with each condition, by event type, can be computed from the records contained in the respective medical event files.⁹ For example, one can compute total hospital spending associated with one person's hypertension. In addition to calculating spending by event type, we calculated total nondrug spending—that is, the sum of expenditures on the six event types listed above. The MEPS data enable us to control for many important attributes including sex, age, education, race, income, insurance status (whether the person is covered by private insurance, Medicare, or Medicaid), who paid for the drug, the condition for which the drug was prescribed, how long the person has had the condition, and the number of medical conditions reported by the person.

Medical conditions are reported by the respondent and recorded

EXHIBIT 1 Frequency Of And Spending For 1996 MEPS Events

Event type	Number	Average expenditure	Total expenditure	Percent of total expenditure
Inpatient visit	2,207	\$7,587.60	\$16,745,833	41.5%
Office-based visit	100,320	81.45	8,170,815	20.2
Prescribed medicine	171,587	32.77	5,623,511	13.9
Outpatient visit	9,957	412.55	4,107,802	10.2
Dental visit	22,165	142.92	3,167,747	7.8
Emergency room visit	3,899	345.34	1,346,490	3.3
Other medical expenditure	6,402	189.70	1,214,484	3.0
All	316,537	127.56	40,376,682	100.0

SOURCE: Author's calculations based on 1996 Medical Expenditure Panel Survey (MEPS) microdata.

by the interviewer as verbatim text and are then coded to fully specified 1996 *International Classification of Diseases*, Ninth Revision, Clinical Modification (ICD-9-CM) codes by professional coders. Codes were verified, and error rates did not exceed 2.5 percent for any coder. To preserve respondents' confidentiality, nearly all of the condition codes are collapsed from fully specified codes to (about 500) three-digit code categories.

By controlling for condition, we are in effect comparing individuals only to other individuals with the same condition. We do not control for drug class, however, since we do not want to rule out comparisons between persons consuming drugs in one class (such as selective serotonin reuptake inhibitor, or SSRI, antidepressants) and persons consuming drugs in another class (such as tricyclic antidepressants) for the same condition.

The first approach we used to determine the *ceteris paribus* effect of drug age on outcomes and spending was to include, in a very non-restrictive fashion, all of these factors as covariates. Age of drug was defined to be (the logarithm of) the number of years prior to 1996 that the active ingredient in a prescription consumed by a specific person was first approved by the FDA.

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The dependent variables used in the models were (1) mortality: whether a person died by the end of the survey period; (2) morbidity indicators: whether a person missed work or school days or spent days in bed due to the condition for which a particular prescription was used; and (3) for each person, the number of, and spending for, nondrug medical events, by type, associated with the condition.¹⁰

This first approach controls for many potentially relevant determinants of morbidity, mortality, and health care spending that may be correlated with the age of drugs used. But there may be other, unmeasured determinants, such as the physician's "practice style": Physicians prescribing older drugs might be less well trained, less likely to keep up with advances in medicine, and more likely to practice in substandard facilities. Fortunately, the fact that many persons in the sample have both multiple medical conditions and multiple prescriptions means that we can control for all individual characteristics—both observed and unobserved—by pursuing a second approach. This involved estimating a model that includes "individual effects."¹¹

Estimates of the parameter of interest in this second approach are based entirely on the correlation within a particular individual between the dependent variable and drug age, not on the correlation between individuals.¹² Suppose a person has two conditions, asthma and hypertension, and is taking medications for both. He may have above-average numbers of hospital stays for both conditions, com-

pared with others having the same conditions. And he may be taking older-than-average drugs for both conditions, because of his physician's practice style, for example. But in the presence of individual effects, the effect of drug age would not necessarily be positive. For this parameter to be positive, the condition for which the age of the person's medications were more above average (relative to both individual and condition means) would need to be the same as the condition for which his hospital stays were more above average.

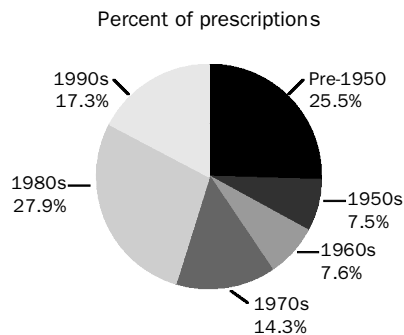
Empirical Results

About one-fourth of prescriptions consumed in 1996 were for drugs approved before 1950; more than half of the drugs consumed were approved before 1980 (Exhibit 2). Exhibit 3 shows the drug classes with the largest number of prescriptions in 1996. Exhibit 4 shows the distribution of people in the MEPS sample, by number of reported medical conditions. Almost two-thirds of persons in the sample have two or more conditions; almost 95 percent of conditions are experienced by persons who have more than one condition.

In the first model approach, which controls for observed individual attributes such as age and education but excludes individual effects, the first dependent variable considered was the amount paid for the prescription. The estimates indicate that drug age is negatively associated with the amount paid for the prescription ($t = 97.74; p < .0001$), confirming the finding of previous studies that new drugs are, on average, more expensive than old drugs prescribed for the same condition. For example, if a fifteen-year-old drug were replaced by a 5.5-year-old drug, the cost of the prescription would increase by about \$18.

EXHIBIT 2

Frequency Distribution Of MEPS Prescriptions, By Date Active Ingredient Was Approved, 1996



SOURCE: Author's calculations based on 1996 Medical Expenditure Panel Survey (MEPS) Prescribed Medicine Event file (MEPS HC-010A); Mosby's GenRx; and unpublished Food and Drug Administration data.

EXHIBIT 3
Drug Classes With The Largest Number Of Prescriptions In 1996

Drug class	Prescriptions	
	Number (millions)	Percent
Calcium channel blocking agents	83.0	5.1%
Upper respiratory combinations	77.7	4.8
Nonsteroidal anti-inflammatory agents	73.8	4.6
Aminopenicillins	66.4	4.1
Narcotic analgesic combinations	63.2	3.9
Angiotensin converting enzyme (ACE) inhibitors	60.6	3.7
Estrogens	52.5	3.2
Thyroid drugs	41.2	2.5
SSRI antidepressants ^a	41.1	2.5
Beta-adrenergic blocking agents	39.7	2.4
Macrolides	37.6	2.3
H2 antagonists	35.1	2.2
Sulfonylureas	34.1	2.1
Adrenal cortical steroids	32.9	2.0
Loop diuretics	31.8	2.0
HMG-CoA reductase inhibitors ^b	31.1	1.9
Minerals and electrolytes	30.5	1.9
Insulin	29.9	1.8
Topical anti-infectives	29.6	1.8
Topical steroids	24.8	1.5
Antihistamines	24.4	1.5
Antianginal agents	22.8	1.4
Inotropic agents	21.6	1.3
Second generation cephalosporins	20.1	1.2
Respiratory inhalant products	19.8	1.2
Natural penicillins	19.1	1.2
Benzodiazepines	18.6	1.1
Nasal steroids	18.1	1.1
Miscellaneous antipsychotic agents	16.3	1.0
Progestins	16.3	1.0

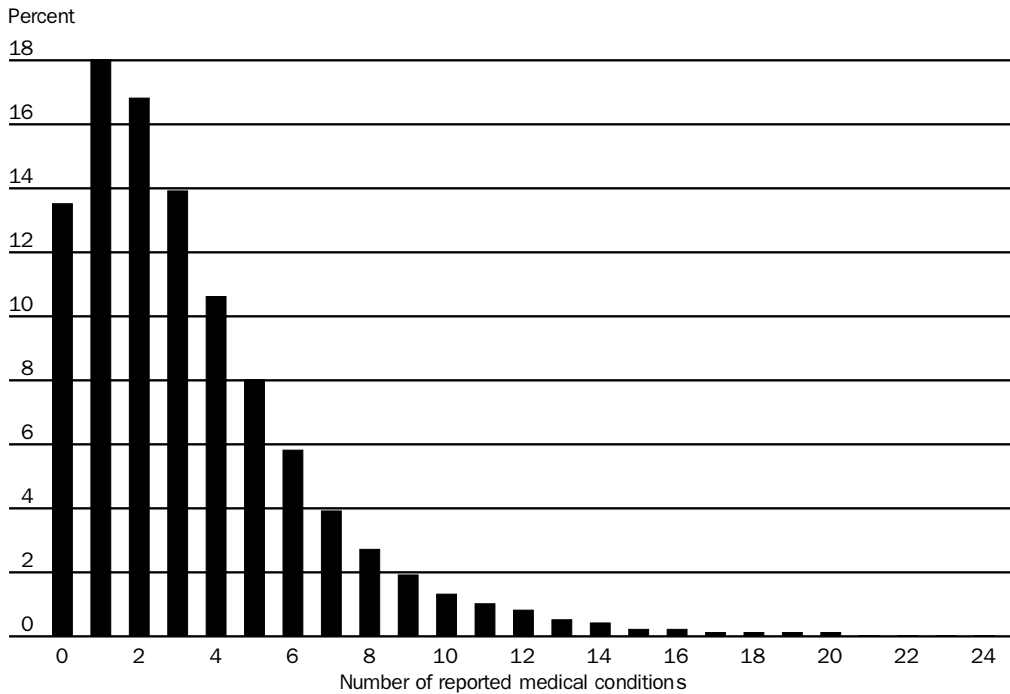
SOURCE: Author's calculations based on 1996 Medical Expenditure Panel Survey (MEPS) Prescribed Medicine Event file (MEPS HC-010A) and Multum's Lexicon.

NOTE: Only those drug classes accounting for at least 1 percent of total prescriptions are shown.

^a Selective serotonin reuptake inhibitor.

^b 3-hydroxy-3-methylglutaryl-coenzyme A.

The second dependent variable considered was mortality. The mortality rate in this sample is quite low: only 0.28 percent (sixty-five) of the 23,230 persons died by the end of Survey Round 3. This would seem to make it very difficult to detect any effect of drug age on mortality. But because the unit of observation is the prescription, not the person, the fraction of observations in which mortality occurs is higher than 0.28 percent. Persons with more prescriptions and more conditions have a higher probability of death. The fraction of conditions in which mortality occurs is almost twice as high—0.48 percent (371 out of 76,602). The estimates indicate that persons consuming new drugs were significantly less likely to die by

EXHIBIT 4**Distribution Of Persons In MEPS Sample, By Number Of Reported Medical Conditions, 1996**

SOURCE: Author's calculations based on Medical Expenditure Panel Survey (MEPS) 1996 Medical Conditions file (HC-006R).

NOTE: Although the file contains reports of up to forty-six conditions, the small number of entries past twenty-four precluded their inclusion.

the end of Round 3 than were persons consuming older drugs ($t = 2.76; p = .0058$).

Next we considered morbidity indicators. Of all conditions, 14.7 percent were associated with any work-loss days; 9.0 percent with any school-loss days; and 14.0 percent with any bed days.¹³ Drug age is not significantly related to school-loss days and only marginally related to bed days. But the estimates for work-loss days indicate that persons consuming new drugs were significantly less likely to experience work-loss days than persons consuming older drugs were ($t = 3.32; p = .0009$). Although this effect is highly statistically significant, it does not seem very large. Using a newer medication that would increase the cost of the prescription by \$18 would reduce the probability of any work-loss days by 0.0040. If the increase in prescription cost were to be justified solely on the basis of reduced work-loss days, the average cost of work-loss episodes would have to exceed \$4,500 ($\$18/0.0040$).

Hospital stays account for almost 42 percent of total medical spending (Exhibit 1). The relationship between drug age and the

number of hospital stays associated with the condition is positive and highly significant ($t = 3.69$; $p = 0.0002$), indicating that persons consuming newer drugs had significantly fewer hospital stays than persons consuming older drugs had. Replacing an older drug with a newer one as in the previous examples would reduce the expected number of hospital stays by 0.0059. Since the average expenditure on a hospital stay in MEPS is \$7,588, one might expect a \$44 reduction in hospital spending ($0.0059 \times \$7,588$), compared with an \$18 increase in drug cost. However, the regression of a person's actual hospital expenditures associated with a condition indicates an even larger reduction in hospital spending from the use of newer drugs: The implied hospital cost reduction is \$56. Use of newer drugs is evidently associated with less expensive (shorter), as well as fewer, hospital stays. This finding is consistent with more aggregate (disease-level) evidence presented in previous research.¹⁴

The estimates indicate that user of newer drugs tends to reduce all types of nondrug medical spending, although the reduction in inpatient spending is by far the largest. This reduction of \$71.09 in nondrug spending is much greater than the \$18 increase in prescription cost, so using a newer drug results in a substantial net reduction in the total cost of treating the condition.

The estimates based on models that include individual effects are quite similar, broadly speaking, to the estimates based on models without individual effects, described above.¹⁵ They also suggest that persons consuming new drugs were significantly less likely to experience work-loss days than were persons consuming older drugs, although the estimated effect is about 30 percent smaller. The estimated effect of drug age on total nondrug expenditure to treat the condition is almost identical—\$72.22—but the distribution of cost reduction by event type is somewhat different. When individual effects are included, the reduction in inpatient spending accounts for an even higher proportion (89 percent) of the total reduction in nondrug spending.

The estimates we have described were based on a pooled sample covering all conditions and all demographic groups. Although, as noted above, we controlled for condition and other factors, that procedure imposes the restriction that the effect of drug age does not vary across conditions or demographic groups. In principle, relaxing this assumption is desirable, and it is feasible to do so in certain respects. For example, it is possible to estimate the nondrug medical spending model separately for those under and over age sixty-five, and we have done so. The estimates indicate that nondrug medical spending is positively related to drug age for both groups. The drug-age coefficient for the elderly (126.7; $t = 5.51$) is about three

times as large as it is for the nonelderly (38.3; $t = 2.09$). But the average level of medical spending is much higher among the elderly, so drug age appears to have similar effects, in percentage terms, on the nondrug medical spending of the elderly and the nonelderly.

One might also like to estimate the effect of drug age on outcomes and spending, by condition. But despite the overall richness of the MEPS data, this is unlikely to be achievable, at least for the majority of conditions. Health spending and outcomes are quite idiosyncratic and heterogeneous, which implies that fairly large samples are required to test hypotheses about their determinants. More than 500 conditions are represented in MEPS, so the average number of usable observations (prescriptions) per condition is just over 200. Of course, the distribution of prescriptions is highly skewed—a small number of conditions account for a substantial fraction of total prescriptions. There are thirteen conditions for which there were at least 2,000 prescriptions.¹⁶

We estimated models that allowed for different coefficients on drug age for each of these conditions. The standard errors of the coefficients tended to be about six times as large as the standard errors of the pooled estimate, and most of the condition-specific drug-age coefficients were not significantly different from zero. The effect of drug age on the mortality dummy variable in model 1 was positive and significant at the 5 percent level for two conditions—disease of lipid metabolism (.041) and ill-defined heart disease (.016)—and negative and significant for one—depressive disorder (-.009). The effect of drug age on the number of missed work days in model 2 was positive and significant for four conditions—chronic sinusitis (.024), disease of lipid metabolism (.018), allergic rhinitis (.016), and diabetes mellitus (.014)—and negative and significant for none. The effect of drug age on total nondrug expenditure in model 2 was positive and significant for two conditions—ill-defined heart disease (280) and arthropathies (171)—and negative and significant for none.

■ **Study limitations.** This study was subject to a number of data and computational limitations. First, as noted above, to obtain precise estimates of the effect of drug age on outcomes and spending for specific conditions, larger samples are required. Second, we analyzed only one indicator of drug quality: years since FDA approval. Other indicators, such as FDA evaluation of therapeutic potential, sales, and international diffusion, might be investigated. Third, we did not account for the fact that a drug consumed for one condition may affect spending and outcomes for other conditions. Fourth, we analyzed the consequences of access to newer drugs, not the determinants of access. Fifth, the measures of morbidity (for example,

work-loss days) we used were binary rather than continuous. Sixth, our controls for severity of illness, such as duration of condition and number of comorbidities, were imperfect. Future waves of MEPS may allow for better controls, such as prior medical spending on the condition. Finally, the large number of parameters precluded estimation of models using theoretically preferable limited dependent variable techniques.

SPENDING FOR PRESCRIPTION DRUGS in the United States has grown dramatically in recent years. Previous studies have suggested that the replacement of older drugs by newer, more expensive drugs is one of the most important reasons for this increase, but they did not attempt to measure how much of the difference in prices reflects changes in quality. The results of this analysis provide strong support for the hypothesis that the replacement of older by newer drugs results in reductions in mortality, morbidity, and total medical spending. Drug costs (and changes in drug costs) are visible to the naked eye; identification of drug benefits requires careful analysis of good data. We believe that people making drug policy decisions need to consider the full range of effects, not just the costs, of newer drugs.

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NOTES

1. Author's calculations based on Health Care Financing Administration, "National Health Expenditures by Type of Service and Source of Funds, Calendar Years 1960-1999," <www.hcfa.gov/stats/nhe-oact/tables/nhe99.csv> (2 May 2001); and U.S. Department of Commerce, Bureau of Labor Statistics, Consumer Price Index—All Urban Consumers, Item: Prescription Drugs and Medical Supplies (Washington: BLS, various years).
2. M. Merlis, "Explaining the Growth in Prescription Drug Spending: A Review of Recent Studies," Report prepared for the U.S. Department of Health and Human Services, 8 August 2000, <aspe.hhs.gov/health/reports/drug-papers/merlis/merlis-final.htm> (15 June 2001).
3. G. Grossman and E. Helpman, *Innovation and Growth in the Global Economy* (Cambridge, Mass.: MIT Press, 1991). See also P. Aghion and P. Howitt, "A Model of Growth through Creative Destruction," NBER Working Paper no. 3223 (Cambridge, Mass.: National Bureau of Economic Research, 1990); T.J. Klette and Z. Griliches, "Empirical Patterns of Firm Growth and R&D Investment: A Quality Ladder Model Interpretation," NBER Working Paper no. W5945 (Cambridge, Mass.: NBER, February 1997); and P.T. Segerstrom et al., "A Schumpeterian Model of the Product Life-Cycle," *American Economic Review* 80, no. 5 (1990): 1077-1092.
4. D. Cutler et al., "Are Medical Prices Declining?" NBER Working Paper no. 5750 (Cambridge, Mass.: NBER, September 1996).
5. Significant geographical variation in treatment patterns was first documented by John Wennberg and colleagues, who studied New England hospital mar-

kets. See J. Wennberg and A. Gittelsohn, "Variations in Medical Care among Small Areas," *Scientific American* 246, no. 4 (1982): 120-134. Other investigators have corroborated this finding in many other settings. See, for example, K. McPherson et al., "Small-Area Variations in the Use of Common Surgical Procedures: An International Comparison of New England, England, and Norway," *New England Journal of Medicine* 307, no. 21 (1982): 1310-1313; and S. Folland, A. Goodman, and M. Stano, *The Economics of Health and Health Care* (Upper Saddle River, N.J.: Prentice Hall, 1991), 216.

6. See <www.meps.ahrq.gov/data_pub/hc_toc.htm> (2 May 2001).
7. Because persons can be seen for more than one condition per event, frequencies of events in the conditions file will not match the person- or event-level utilization counts. For example, if a person had one hospital stay and was treated for a fractured hip, a fractured shoulder, and a concussion, each of these conditions has a unique record, and a hospital stay is recorded in each. MEPS HC-006R, C-10, <www.meps.ahrq.gov/Data_Pub/HC_FYData96.htm#hc006> (7 August 2001).
8. Of the remainder, 5.3 percent are linked to more than one condition, and 4.4 percent are not linked to any condition.
9. The MEPS HC010I file (Appendix to MEPS 1996 Event Files) contains the variables needed to link records in the MEPS 1996 event files to records in the MEPS 1996 condition file.
10. The first set of models includes the following regressors: the log of the age of the drug; 513 condition (ICD-9 code) effects; year that condition began (71 categories); number of conditions the patient has (10 categories); patient age (87 categories); patient income (28 categories); education (17 categories); race (5 categories); sex; whether the person is covered by Medicare, Medicaid, or private insurance; and percentage of prescription costs paid by self, private insurance, and Medicaid. Weighting factors included with the MEPS data were applied through a weighted least squares approach in estimating the model parameters. Alternative logit or probit specifications for the mortality and morbidity models, while theoretically preferable, are computationally infeasible, because of the large number of estimated parameters. This may lead to incorrect standard errors, but not to any bias in the estimates.
11. Inclusion of individual effects also helps to address the problem of correlation between the errors of an individual's multiple prescriptions for a given condition. The second set of models includes the following regressors: the log of the age of the drug; 513 condition (ICD-9 code) effects; 12,385 individual effects; the year the condition began (71 categories); and the percentage of prescription costs paid by self, private insurance, and Medicaid.
12. The individual effects capture all attributes of the individual that do not vary across prescriptions and conditions, including sex, age, education, race, income, insurance status, and number of medical conditions reported.
13. The conditions file reports whether or not any bed, work-loss, or school-loss days were associated with a condition, but not the number of days.
14. F. Lichtenberg, "Do (More and Better) Drugs Keep People Out of Hospitals?" *American Economic Review* (May 1996): 384-388.
15. Unlike the morbidity and expenditure variables, the mortality variable does not exhibit any within-individual variation—that is, the cause of death is not indicated—so we are unable to estimate the mortality equation with individual effects.
16. Essential hypertension, diabetes mellitus, asthma, ill-defined heart disease, otitis media, depressive disorder, allergic rhinitis, chronic sinusitis, arthropathies, acute nasopharyngitis, lipid metabolism, menopausal disorders, and bronchitis.