Income, Insurance, And Technology: Why Does Health Spending Outpace Economic Growth?

Insurance’s effect may be less than in the past, particularly in its impact on the use and spread of new medical technologies.

by Sheila Smith, Joseph P. Newhouse, and Mark S. Freeland

ABSTRACT: A broad consensus holds that increased medical capability—technology—is the primary driver of health spending growth. However, technology does not expand independently of historical context; it is fueled by rising incomes and more generous insurance coverage. We estimate that medical technology explains 27–48 percent of health spending growth since 1960—a smaller percentage than earlier estimates. Income (gross domestic product, or GDP) growth plays a critical role, primarily through the actions of governments and employers on behalf of pools of consumers. The contribution of insurance is likely to differ, with less of a push from increasing generosity of coverage and more of a push from changes in provider payment. [Health Aff (Millwood). 2009;28(5):1276–84; 10.1377/hlthaff.28.5.1276]

After temporarily slowing in the mid-1990s, the percentage of U.S. gross domestic product (GDP) devoted to health care has resumed its apparently inexorable rise.1 The troubling implications for the long-term viability of the current U.S. system of financing and providing health services are all too clear. The ability to formulate appropriate policies to reduce health spending growth requires understanding the major factors driving that growth—an urgent task, given the difficulty of making sharp reductions in a short time.

Changing medical technology is one of the few factors that can potentially explain persistently high growth in medical spending over time and across many countries.2 Indeed, the dominant role of technology as a driver of spending has become a truism in health economics.3 The conclusion that technological change explains much of the growth rests on a macroeconomic approach that seeks to esti-
mate the contribution of known factors to health spending growth and assumes that most of the unexplained residual growth is attributable to technology. Joseph Newhouse's 1992 and 1993 papers are well-known examples of this approach. He concluded that if technology had been constant, demographic changes, income growth, and insurance growth would have accounted for "well under half—perhaps under a quarter"—of the increase in medical care spending between 1940 and 1990. An expanding number of empirical studies on specific medical technologies support the key role assigned to technology but are largely agnostic on the magnitude of its effect in the aggregate.

In this paper we update Newhouse's 1992 estimate with seventeen more-recent years of data and revise his methodology to reflect subsequent research. The contribution of technology by itself to health spending growth is smaller than his earlier estimate suggests. But the interrelationships among technology, income, and insurance are strong; the burgeoning of medical technology since World War II did not occur in isolation but, rather, in the context of growing economies and health care financing institutions that facilitated technology's development and diffusion. These interrelationships make it difficult to assign specific quantitative magnitudes to each factor, although we seek to provide ranges.

In our work, growth in aggregate income (GDP) stands out as an important driver of health care cost growth, despite the small role income plays in insured households' health care decisions. Theory and recent empirical work suggest that the generosity of insurance coverage has also stimulated technological change. Looking forward, its role could well differ from its role in the past: there is less room for rising generosity of coverage and the probability of a continued evolution in the structure and constraints.

Study Data And Methods

The primary objective of the original Newhouse estimate was estimating welfare loss—the costs to society from excessive spending on medical care resulting from insurance—and to argue that the economics literature at that time overestimated that loss. In this work we changed the objective from estimating welfare loss to estimating the relative contribution of various drivers of long-term growth in aggregate health spending. This prompted two changes in methodology.

First, we changed the method used to estimate the importance of each causal factor as a driver of spending growth. This new method shows that several factors contributing to growth, such as economic prosperity, rising medical prices, and expanding insurance coverage, played major roles; it implies a smaller role for medical technology than in the original Newhouse estimate.

Second, to approximate the magnitude of the aggregate income effect, we relied on estimates based on how health spending varies across countries and time. The consensus that technology is the major driving factor was built using estimated income and insurance effects at the household level, especially estimates from the
RAND Health Insurance Experiment (HIE). These implied that variation in income, insurance, and demographics across households explained little of the growth in aggregate health spending over time.\(^8\)\(^9\) The most plausible inference was that changing technology accounted for much of the growth.

Since that time, there has been growing recognition that the responsiveness of health spending to income and insurance is larger at the macro or country level than at the household level.\(^10\)\(^–\)\(^16\) The large residual implied by using household-level income estimates overstates the pure contribution of technology to aggregate health spending growth. Insurance—as well as income—likely has effects that are larger at the macro level than household variation suggests. However, we continue to rely on the HIE for this purpose, because the uncertainty on this question precludes generalization of the size of this effect at the macro level.

The gap between the micro and the macro estimates of the effects of income is partly attributable to measurement problems and aggregation issues, but it likely reflects economic factors as well. In particular, the rate of technological innovation is influenced by the size of the market, which in turn is influenced by income and insurance.\(^14\)\(^,\)\(^17\) Using macro estimates of the magnitude-of-income effects is more appropriate for analysis of spending growth at the national level.\(^10\) However, this does make it more difficult to control accurately for the effect of all factors that may influence growth and to estimate the interactions among them.

The effects of income, insurance coverage, and medical technology on health spending clearly form a critical nexus. In the interest of brevity, we focus our discussion on these three factors and relegate much of the supporting technical work to an appendix, including our estimates of demographic effects.\(^7\) We do not quantify the role of administrative costs, the health status of the population, supplier-induced demand, and potential inefficiency due to professional liability concerns. Spending attributable to most of these factors is simply too small to account for much of the historical growth in health spending.\(^2\) Moreover, these factors are not plausible as consistent drivers of spending growth over all countries in the Organization for Economic Cooperation and Development (OECD) for five decades. To the extent that these factors have caused spending to grow, however, the impact will be reflected in our estimated effects and residual, which will therefore overstate the contribution of income, insurance, and technological change.

**Medical price inflation.** Although it seems natural to use medical price indexes to estimate the direct effect of medical price inflation on spending, we have not done so. The available historical price indexes are widely believed to overstate growth in medical prices by a substantial margin. Rather, we assumed that prices track the average cost of production, determined by the price of inputs and by production efficiency (total factor productivity), and we used estimates of those two terms to derive a measure of medical (output) price growth.\(^18\) We estimated input price inflation for medical care relative to the entire economy using quality-adjusted measures of volume and price of capital, labor, energy, and materials.\(^19\) Our upper-
bound assumption for total factor productivity was 0.8 percent (the economywide average), and our lower-bound assumption was zero.

This methodology implies that rising medical prices contributed 0.2–0.9 percentage points to annual growth in real per capita health spending during 1960–2007, or 5–19 percent of the total (Exhibit 1). The range reflects the alternative assumptions on productivity in health care.

- **Insurance coverage.** Quantifying the effects of insurance on aggregate spending is difficult. Insurance coverage influences health spending through three channels: the proportion of the population with insurance; the depth of coverage in insurance contracts; and the level and structure of reimbursement from insurers, both public and private, to providers. We accounted for all of these channels based on average out-of-pocket share of personal health spending paid by the consumer, which declined from 55 percent in 1960 to 14 percent in 2007. If one uses an estimated insurance elasticity of −0.2 from the HIE, the net expansion in insurance coverage accounted for 10.8 percent of the growth in real per capita health spending.9

This relatively minor role for insurance coverage as a driver of growth based on a household-level elasticity estimate may well be low, however. Because insured patients bear only a fraction of the costs of new technologies and because U.S. reimbursement was largely passive over much of the period, incentives for inefficiently broad application of new technologies and thus higher cost growth rates (dynamic moral hazard) were present.20, 21 Dynamic moral hazard implies that even an unchanging rate of insurance coverage can drive chronic growth in medical spending because of persistent overuse. However, this incentive may be reduced through methods of payment that cut the link between payment and volume of care (for example, prospective payment or other methods of bundling). Empirically, Amy Finkelstein concludes that the expansion of insurance coverage resulting from the introduction of Medicare and Medicaid eventually had sizable market-level effects on health spending over the years following its introduction.11 Changes in coverage affected a large share of the population and so affected capital investment (for a given technology), standards of care, and the nature of technologies that were subsequently introduced and their rate of diffusion.11, 17, 22

Nonetheless, the magnitude of the effects of market-level changes in insurance coverage (as distinct from household-level changes) on health spending remains highly uncertain. For that reason, we used the 10.8 percent value based on household responses to insurance as the portion of cost growth due to insurance expansion; this means that some of the cost growth that we attributed to income and technology may actually be attributable to insurance.

- **Income effects.** Income (real per capita GDP) is a critical factor in determining how much nations spend on medical care; it consistently explains around 90 percent of variation in real health spending across countries and time. Recent estimates tend to find a macro-level income elasticity of about 1.0, implying that health spending moves in tandem with GDP.15, 23 However, the raw or unadjusted elasticity
Between real per capita health spending and real per capita GDP is much higher—about 1.4–1.7. This unadjusted value, which we call an expenditure elasticity, reflects not only a pure income effect but also other factors affecting health spending that are correlated with real per capita GDP. This arguably includes a good part of the impact of technology, medical prices, and insurance.

We used the raw expenditure elasticity to derive an estimate of a pure income effect, using a standard model to estimate an adjusted elasticity. That model is simple: real per capita health spending is estimated as a function of real per capita GDP and a set of variables that capture variation in demographic variables and in specific characteristics of the various countries’ health systems. In addition, the model includes two-way fixed effects (meaning a set of yearly dummy variables that measure trends common to all countries over time, and also a constant for each country that is unvarying over time).

This model is appropriate for estimating income elasticity but is less helpful for projecting health spending growth. For forecasting purposes, using this model simply shifts the forecasting problem to one of forecasting future period (year) ef-

**EXHIBIT 1**
Percentage Of Average Annual Growth In Real Per Capita Health Spending Attributable To Various Causal Factors, 1960–2007

<table>
<thead>
<tr>
<th>Medical care productivity = economy average</th>
<th>Medical care productivity = zero</th>
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</thead>
<tbody>
<tr>
<td>Income elasticity</td>
<td>Income elasticity</td>
</tr>
<tr>
<td>(1)*</td>
<td>(2)*</td>
</tr>
<tr>
<td>Income effects</td>
<td>0.6</td>
</tr>
<tr>
<td>Relative medical price inflation</td>
<td>28.7%</td>
</tr>
<tr>
<td>Demographic effects</td>
<td>5.0</td>
</tr>
<tr>
<td>Change in insurance coverage</td>
<td>7.2</td>
</tr>
<tr>
<td>Technology</td>
<td>10.8</td>
</tr>
<tr>
<td>Technology-income interaction</td>
<td>48.3</td>
</tr>
<tr>
<td>Technology residual</td>
<td>27.4</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
</tr>
</tbody>
</table>

**SOURCE:** Authors’ calculations; see below.

**NOTES:** Minimum contribution of technological change is based on the difference between the unadjusted expenditure elasticity and the expenditure elasticity with controls for common trend in health spending across Organization for Economic Cooperation and Development (OECD) countries (fixed effects) over time. The contribution of relative medical price inflation has been adjusted downward for this scenario, to prevent the contribution of technology from falling below this minimum. Income is real per capita disposable personal income, five-year moving average. Relative medical price inflation is the Centers for Medicare and Medicaid Services (CMS) personal health care price deflator, adjusted by constant trend to adjust for bias consistent with assumptions. Insurance coverage is the National Health Expenditures Accounts (NHEA) out-of-pocket spending as share of total personal health care spending. For all columns, estimates for the contribution of insurance and demographics remain the same; only income and price effects vary: demographic estimate based on CMS age-sex indexes, which are largely based on data from the Medical Expenditure Panel Survey (MEPS) with supplemental data for institutional settings. Insurance coverage is based on arc elasticity from the RAND Health Insurance Experiment. TFP is total factor productivity. Factor price inflation from Ho/Samuels database.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Expenditure elasticity</th>
<th>Income elasticity</th>
<th>Price elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)*</td>
<td>1.6</td>
<td>0.6</td>
<td>-0.2</td>
</tr>
<tr>
<td>(2)*</td>
<td>1.6</td>
<td>0.9</td>
<td>-0.2</td>
</tr>
</tbody>
</table>

*Expenditure elasticity = 1.6; income elasticity = 0.6; price elasticity = -0.2.
fects. Nonetheless, with an additional assumption, this model is useful for our purposes. That additional assumption concerns the interpretation of the yearly dummy variables that measure changes in spending that are common across countries. We assumed that these are most plausibly attributed to the common effect of medical technology. They also include the effects of any common income and insurance trends, but because a country’s deviation from the common income trend is included in the model and because common insurance trends are probably small, we believe that the bulk of this measure is the common effect of technology, and probably accounts for most of the effect. Micro-level evidence on the diffusion of specific technologies supports this view, because early adoption and rapid diffusion of new technologies are frequently linked to real per capita GDP.\(^{25}\) Interpreting these period effects as technology and taking them out of the expenditure elasticity leaves a remaining (partial) expenditure elasticity of 1.0 for 1960–2007.

To derive the pure effect of income, we also needed to account for the role played by price. William Baumol’s well-known “cost disease” model suggests that productivity growth may be intrinsically low (and price inflation relatively high) for medical services, which are necessarily highly customized.\(^{26}\) To the extent that this model holds, it implies that higher-income countries will have higher relative medical prices, which could account for part of the relationship captured in the expenditure elasticity. We approximated the potential magnitude of this interaction effect based on the same upper and lower bounds for total factor productivity discussed earlier. We found that this effect lowers the expenditure elasticity by a further 0.2–0.4. The remaining 0.6–0.9 of the expenditure elasticity we interpret as the income effect.\(^{27}\) This estimate implies that 27–43 percent of growth in real per capita health spending is attributable to income growth (Exhibit 1).

We explored whether we needed to make a further adjustment for the role of insurance using the out-of-pocket spending share as a proxy for coverage variations across countries. Theory is ambiguous on the question of whether higher incomes will raise or lower preferred levels of insurance coverage, and we found an (insignificant) effect that did not materially influence the estimated income elasticity.\(^{27}\)

**Discussion**

Real per capita health spending grew roughly by a factor of 9 during 1960–2007— an annual growth rate of 4.8 percent. Spending on new medical technologies accounted for 27–48 percent of this amount. Income accounted for a roughly similar amount—another 29–43 percent. Economic theory suggests that these two forces reinforced each other (Exhibit 1).

Increases in unit price accounted for 5–19 percent of the increase in health spending, depending on how productivity changed in medical care. The smaller the productivity increase in medical care relative to the economy as a whole, the greater this value. Demographics appear to have played a small role in the historical growth of spending\(^{7}\) but will loom larger with the aging of the baby boomers.
Why is the aggregate relationship so strong between income and spending when the income effect at the household level is small? A main reason is insurance; a household only pays for care net of insurance, but our results imply that countries have mechanisms to adapt their spending to their incomes.

- **Applicability of the model to U.S. experience.** It is natural to ask how well our model, using data from twenty-three countries, tracks U.S. historical experience. To do so we followed the standard Centers for Medicare and Medicaid Services (CMS) assumption that the macro-level response to a change in demand for medical care occurs with moving average lag of five years; that is, we calculated the average of the prior five annual values for income and used that average to predict current health spending for a given year. Changes to the structure of insurance contracts between (public and private) insurers and providers and the regulatory infrastructure require a lengthy decision-making process, followed by a period of implementation. With this assumption, our model tracks growth in real per capita health spending remarkably well over time (Exhibit 2). That this estimate, rooted in empirical estimates of causal factors that explain international variation in spending, can so effectively fit historical growth in U.S. health spending adds plausibility to our estimates of the roles of each of the major drivers of cost growth.

**EXHIBIT 2**
Contribution Of Medical Technology And Non-Technology Factors To Growth In Real Per Capita Health Spending, 1964–2007

<table>
<thead>
<tr>
<th>Percent change</th>
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<tbody>
<tr>
<td>9</td>
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<tr>
<td>8</td>
</tr>
<tr>
<td>7</td>
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<tr>
<td>6</td>
</tr>
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<td>5</td>
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<td>4</td>
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<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

Real per capita health spending predicted by decomposition

Real per capita health spending

Contribution of medical technology (smoothed)

Contribution of non-technology factors

**SOURCE:** Authors’ calculations of data from the Centers for Medicare and Medicaid Services.
Speculation about the future. Our model suggests that the unusual severity of the current recession will reduce spending growth in the near term by an amount roughly comparable in magnitude to that of the managed care era of the 1990s. Unfortunately, the model says nothing about how that reduction may be brought about.

The rising generosity of insurance accounted for a relatively small share of growth based on household estimates, but its role as a driver of technology was important. It is likely to be less so in the future. Of course, the potential exists for a substantial near-term stimulus to the demand for medical care if coverage is expanded to the currently uninsured population. Over the longer term, however, insurance is not likely to exert as large a positive effect on spending as it has historically, because it already covers 86 percent of personal health care spending, up from 45 percent in 1960. Moreover, insurance reimbursement in both public and private insurance has evolved from the passive indemnity fee-for-service coverage of 1960 to much more active roles for both private and public insurers. Networks of providers are now almost universal in private insurance. Diagnosis-related groups (DRGs) for prospective payment were introduced by Medicare and then adopted by many private insurers, and there is now discussion of further broadening the basis of payment to episodes of care. In short, insurance may play a less stimulative role than in the past because reimbursement could be less passive and because the out-of-pocket spending share will not fall by the amount it has in the past.

Income growth will continue to drive a rising health share of GDP in decades to come, as spending on new medical technologies continues to increase more rapidly than incomes. Ultimately, this effect must diminish as the opportunity cost of additional growth in health spending rises—exacting a growing trade-off in the forgone consumption of all other goods and services.

The authors thank Steve Heffler, John Poisal, and Sean Keehan for comments on an earlier draft. The views expressed are those of the authors and do not represent the position of the Centers for Medicare and Medicaid Services.

NOTES
7. See the technical appendix at http://content.healthaffairs.org/cgi/content/full/28/5/1276/DC1.
8. Manning W, et al. Health insurance and the demand for medical care: results from a randomized experi-
24. This range reflects variation in sample across countries or time. Estimates for later time periods tend to be on the lower end of this range.
29. This assumes that the effect of insurance on spending does not increase.