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Modeling the Cost of Medical Care for the Elderly

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Forecasts need to be accurate, timely and comprehensible. The challenge of predicting medical costs 20, 30 or 50 years into the future is formidable, but some organizations (Medicare, employers with retiree health plans) have no choice: They must make decisions today affecting funding for the rest of the century. While the complexity of the task seems overwhelming, the best and most readily understood results often come from rather simple macro models that rely on a few key parameters, rather than micro models that simulate detailed interactions among a myriad of individuals and illnesses. This excerpt from a presentation at the January 2014 Society of Actuaries' Living to 100 Symposium (http://livingto100.soa.org/) describes an open-source model for use by actuaries attempting to estimate future health benefit costs, discusses its strengths and limitations, and projects that spending for those age ≥65 will take more than $13 trillion by 2055, about 50 percent of total medical expenditures.

Macro Model for Long-Term Medical Cost Trends

In 2006, the SOA posted a request for proposal (RFP) to develop "Models of Long-Term Medical Trends for Valuation" of retiree health benefits. The result of that effort was a parsimonious macroeconomic Excel model to project cost trends from 2015 to 2099 (SOA 2011). This model, with subsequent updates, was adopted by many actuaries as a standard tool. The model split health care cost trend into three components:

$$\underset{\text{(consumer price index)}}{\textit{TREND} = \textit{inflation}} \quad + \quad \underset{\text{(gross domestic product/wages)}}{\textit{real growth}} \quad + \quad \underset{\text{(technology/demand)}}{\textit{medical share}}$$

To the extent that the medical cost trend is matched by growth in wages, the share of total earnings required to fund future health benefits remains steady. Thus most interest has been focused on the last factor, often termed "excess cost growth" by Medicare and the Congressional Budget Office.

As the original model was being constructed, questions were raised about the higher costs of older retirees. Although costs per person age ≥65 were clearly larger, and commonly perceived to be growing much faster, analysis of data for the prior 25 years showed that relative growth in spending was actually slower, especially among the most advanced age groups (≥75, 85). Rather than attempt to reform a deeply held, albeit incorrect, public opinion, a decision was made that the original model would not project separate cost trends for people over/under age 65.

Extending the Model to Determine the Share of Expenditures for Age ≥65

Developing a new paper provided an opportunity to explore the issue of age-related costs in greater depth, with more data, and within a larger perspective that highlights the total amount of expenditures for care of the elderly. The baseline projections in this article continue to use equal trends in per-person medical costs over and under age 65, but do so in a more nuanced context, exploring the reasons for staying with the original baseline, and for how and why divergences might occur that would substantially change results. The original model is extended by including:
i. the ratio of costs per person over/under 65, and
ii. the fraction of total population age ≥65.

($Share ≥65) = (medical share of GDP) x (% age ≥65) x (cost ratio)

Retrospective analysis is provided in Table 1 on page 22. Reliable data on spending by age group are difficult to come by, and availability dictates the choice of years to measure growth in relative costs. The first line presents previous results: The share of GDP quadrupled from 4 percent to 16 percent from 1953–2004, an annualized rate of growth in share (excess costs) of +2.7 percent. Population estimates from the Census Bureau are shown in the second line: The percentage age ≥65 rose from 8.5 percent in 1953 to 12.2 percent in 1987 and 12.4 percent in 2004, indicating

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Table 1. Cost of Medical Care for the Elderly					
	1953	1963	1987	2004	Growth '53–'04
National health expenditure share of GDP	.041	.057	.110	.160	2.7%
% Pop ≥65	8.5%	9.4%	12.2%	12.4%	0.7%
$ per capita ≥65	$109	$299	$5,830	$14,797	
$ per capita <65	$65	$127	$1,088	$3,953	
in nominal 2009 dollars					
cost ratio old:young	1.7	2.4	5.4	3.7	1.6%
% $ spending ≥65	13%	20%	43%	35%	1.9%
≥65 share of GDP	.006	.011	.047	.055	4.6%
≥65 $ (billions)	$2.1	$6.9	$222	$657	11.9%

that the rise in the fraction of the elderly population had been almost negligibly small in the most recent years, and averaged only 0.7 percent per year over the entire 50-year period. Expenditures on the elderly had already begun to rise rapidly before the advent of Medicare in 1965, but then soared to 536 percent of the average cost for younger people in 1987. Since then, however, medical costs for older people continued to rise but less rapidly than average costs for younger people. Moderation in annual cost increases is particularly evident at advanced ages (75+ and 85+, not shown here).

As with health care spending in general, the main factor driving expenditures on care of the elderly is the growth of the overall economy. The 11.9 percent annualized rate of increase from 1953–2004 can be decomposed as growth of GDP, growth in the share of GDP devoted to medical care and growth in the percentage of health spending attributable to the elderly. Just as the annualized rate of growth in GDP (7.0 percent) can be decomposed into components of real incomes per capita (+2.1 percent), inflation (+3.6 percent) and population (+1.2 percent) as shown in Table 2, the rise in the percentage of health care costs attributable to the elderly can be decomposed into growth in the fraction of population age ≥65 (0.7 percent) and growth in the ratio of cost per elderly person relative to the mean (+1.2 percent).[1]

Table 2. Annual Rate of Growth in Health Spending Age ≥65, 1953–2004			
	2.1%	Real income per capita	
	3.6	Inflation	
GDP	1.2	Population	(7.0%)
Medical	2.7	Health share ("excess")	(9.9%)
	0.7	% Population age ≥65	
≥65 Medical	1.2	$ cost ratio old:average	(11.9%)

The rate of increase in spending for the elderly was more than twice as rapid during the first half of this period than the second half (14.7 percent vs. 6.6 percent). Population aging decelerated, but the main factor causing the change in trend was a reduction in relative spending on the elderly (cost ratio), which was 1.7 in 1953, rose rapidly to 5.4 by 1987 and then fell to 3.7 in 2004.

Forecast Application: Estimating Future Expenditure Liabilities

As shown in the first line of Table 3, extrapolation using the annual excess cost growth rate (+1 percent) implicit in the most recent Centers for Medicare and Medicaid Services (CMS) Office of the Actuary national health expenditure (NHE) projections yields a rise in projected health spending from 17.9 percent of GDP in 2012 to 26.3 percent by 2050 (Getzen 2013). Census Bureau midline projections indicate that the fraction of the population age ≥65 will rise from 14 percent to 21 percent as shown in the second line. If the cost ratio old:young remains at 3.74 as it was when last estimated (in 2004), then the percentage of health expenditures attributable to age ≥65 will rise from 37 percent in 2012 to 46 percent in 2025, and reach 50 percent by 2050. Spending on the elderly would grow more than tenfold to $13 trillion in 2050, more than 13 percent of GDP.

Table 3. Projected Future Costs, Age ≥65	2012	2025	2050
Health (NHE) share of GDP	.179	.205	.263
% Pop age ≥65	13.8%	18.8%	20.9%
cost ratio old:young	3.74	3.74	3.74
% $ spending ≥65	37%	46%	50%
≥65 share of GDP	.067	.095	.131
≥65 $ (billions)	$1,062	$2,832	$13,202

Uncertainties and Limitations of the Macro Model

Assuming that medical costs for people age ≥65 relative to those under 65 remains at 3.7:1 is a large and uncertain if. In the previous five decades, the ratio has ranged from 1.7 to 5.4. The baseline projection implies 50 percent of total health expenditures would be for those age ≥65 by 2050. This percentage would decline to 40 percent if the ratio were 2.5, and rise to 54 percent if the ratio were 4.5. The top and bottom of the historical range would indicate even larger shifts. Although future cost ratios that depend on the vagaries of a complex health system and the whims of legislators can be expected to move somewhat unpredictably within a sizable range, the essential demographic factors (population growth and fraction of the population age ≥65) are much less uncertain and lie within a much smaller range, even out to 2050 and beyond. Current census bureau projections for the proportion age ≥65 in 2060 has a low of 21.3 percent and high of 22.6 percent, a range of just ±0.7 percent.

The rate of increase in national health expenditures in excess of GDP is likely to be the second largest source of uncertainty. The most recent CMS estimate for excess growth in medical costs averaged +1 percent for the next 10 years, which is used as a default baseline here. However, anything from +0.5 percent to +2.5 percent can be quite reasonably defended. A quantification of the range of uncertainty is speculative at this point, but the likelihood of being inside that defensible range is probably on the order of 90 percent (Getzen 2013). Uncertainty regarding the rate of growth in GDP is perhaps even larger, and certainly more important in terms of public welfare, but falls outside the scope of health care forecasting. The CMS projected rate of long-run growth in real income per capita of 1.4 percent is reasonable as an estimate of central tendency, but the average actual rate exceeded 2.0 percent for the last half of the 20th century, and the recent recession has so shaken the confidence of some economists that they predict long-run average growth of just 1 percent or less. Inflation, assumed by CMS to lie mostly between 1 percent and 4 percent, is generally considered to be almost unpredictable over the long run. It is also essentially irrelevant to the extent that prices, costs, wages, taxes and so on all move together and hence do not materially affect "real" resource use or growth in the long run.

This forecast of future health spending for the elderly depends heavily on two distributional parameters, what share of total resources available should be spent on health (health share of GDP) and what fraction of that health spending should be devoted to the elderly (percent of health care spending for those ≥65). Both are determined primarily by politics and social choice rather than demographics or biology.

What Effect Will the ACA Have on Health Spending Trends?

From a long-run macro perspective, legislation such as the Home Maintenance Organization (HMO) Act of 1973, Tax Equity and Fiscal Responsibility Act (TEFRA) of 1982, Employee Retirement Income Security Act (ERISA) of 1974 and the Affordable Care Act (ACA) of 2010 are part of the

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process by which spending is managed. They are visible traces of internal workings within a complex system that shape costs to conform with underlying economic, demographic and technological trends in ways that people want. Unlike earthquakes, floods or asteroids, they are not random external events that strike, suddenly shifting resources to cover a loss. Every law has effects, but the enactment and effects depend on forces in play at that time and place, much as the influence of Thomas Jefferson, Abraham Lincoln or Adolf Hitler depended upon the forces in play when they were elected. Medicare is a useful example of the process. While certainly raising spending, it did so within the context of an expanding economy, the ascent of academic medicine, public faith in the power of advancing medical technology, and provider supply strengthened by Hill-Burton Act of 1946 and the Health Professions Act of 1963. These underlying forces had begun to push spending up well before Medicare was enacted. Most legislation shapes continuing trends with only gradual movement up or down. Medicare marked a change in trend—but it was a change already taking place. Medical historians similarly use a single event, publication of the Flexner Report of 1910, as the marker for a revolution in the education of doctors and the social and scientific practice of medicine that was already taking place and continued for years afterward.

Will the ACA eventually come to be seen as marking a turning point like Medicare and the Flexner Report? That depends on history. It also depends on how well the ACA is made to conform to current conditions, or if the act is replaced. “Bending the curve” may ultimately be considered to have started in 1983 or 1994 or 2008 rather than 2014, or as not starting until 2025. What is clear is that excess cost growth and relative per capita spending on the elderly has been mostly slowing down over the last 20 years.

Micro or macro? When to use national aggregates and when to use detailed demographic and biological categories

Macro models are useful when a major element of the total system is more predictable than the individual parts. National health expenditures are well suited to macro modeling because they are allocations of income subject to a budget constraint imposed at the national level, rather than the outcome of individual illnesses or decisions subject mainly to individual budget constraints. Mortality and illness may be individual events, but spending on them is not. The purpose of medical insurance is to aggregate losses and pass the budget constraint on to a larger group (Getzen 2006).

A budget constraint means that errors are not independent, or independently distributed, but are forced in aggregate to sum exactly to 0; no more, no less. A patient seeking treatment is usually no more aware of this constraint on total resources (hospital beds, doctors) than a person buying 18th century chairs, gallons of gasoline or gold krugerrands is aware of total constraints on those items. Individuals experience only how much of their own personal income must be used to obtain an item for themselves, not how much is available in aggregate.

Many projections for the cost of health care begin at the individual level, creating detailed weights by age, sex and morbidity category, multiplying each by a specific disease incidence rate, and then by a cost per illness episode. Finally, costs are summed across categories and types of illnesses and then extrapolated using a general price inflator as in the equation below.

$$\text{Total \$ Cost} = \sum(\textit{age, sex, morbidity category}) \times (\textit{incidence rates}) \times (\textit{cost per case}) \times (\textit{future CPI})$$

Such models may encompass hundreds or even thousands of computations, although it has become common to estimate the cost for just one disease (diabetes, stroke, HIV), type of patient (hospice, obese, bp>140) or provider (ambulatory surgery centers, emergency rooms, MRI facilities) in isolation. A primary weakness of category decomposition models is that the current detailed estimates for weights, rates and itemized costs must all be assumed stable, and then be extrapolated into the future using a multiplier for expected average increase per year—a multiplier that is usually more uncertain and has larger effects on the total than most changes in the projected mix of weights, rates and costs. Categorical extrapolations tend to focus

Table 4. Advantages of Macro Health Modeling	
A.	Accuracy is better (especially when forecasting rather than backcasting)
B.	Empirically sounder, incorporating the central budget constraint
C.	Focuses attention on the system, not the parts
D.	Clarifies the essential choices (What share of GDP? What percent for the elderly?)
E.	Concentrates on largest sources of uncertainty
F.	Highlights policy-relevant variables rather than technical details or immutable facts
G.	Simplification allows time for thought, analysis of long-run determinants and disturbances

on individuals and components rather than the system, and may thus skip over a core fact about spending: budgets matter, and budgets matter absolutely in long-run aggregate totals. To the extent that a forecast is concerned only with a tiny sliver, spending just on MRIs, Oxycontin or BMWs for example, then the aggregate constraint can sometimes be usefully ignored. Budgets cannot be ignored if the expenditure is for a large share, like the 20 percent that will be spent on health care, or even for the half of that amount which will be spent on the elderly. Of course most issues and policy questions benefit from a combination of micro and macro perspectives, selectively combining the strengths of each.

The macro forecast model used here has three elements: the amount of money spent each year (GDP), the share of that spent on health (share), and the fraction of the health share devoted to the elderly (percent of health care spending on those ≥65). This model simplifies and abstracts away from many fascinating details regarding MRIs, microbes, doctors, patients, triple-tiered reimbursement schemes and price transparency. It forces the analyst to concentrate on the system as a whole rather than the individual parts. Such simplification might not be worthwhile if it did not lead to a considerable improvement in accuracy—which it does, routinely yielding far more accurate and comprehensible results than the many intricate large-scale demographic projections of cost by disease category (Getzen 2000, 2006).

END NOTES

[1] Decomposition of a compound rate means that the annual percent growth rates must be multiplied, rather than simply added, and the appropriate multiplier for the cost ratio is the ratio relative to the average, which depends upon the fraction of the population age ≥65 as well as the over:under cost ratio.

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