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DATE: June 2, 2022

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SUBJECT: A Conceptual View of The Long-Term Projection Methods for Medicare and Aggregate National Health Expenditures

Each year, the Office of the Actuary (OACT) produces 75-year Medicare expenditure projections for the annual report of the Medicare Board of Trustees to Congress. The assumptions used in the long-term projections have evolved over several decades through internal deliberations, five independent technical advisory panel reports, ongoing discussions with the Medicare Trustees and their staffs, and the input of various external researchers. This memorandum provides a conceptual description of OACT's long-term projections. For a detailed understanding of long-term projection methods, readers should consult previous iterations of this memorandum.[1]

Overview

Federal law requires the Medicare Trustees to report annually to Congress about the financial and actuarial status of the Medicare program. OACT provides professional technical assistance to the Trustees in their preparation of this report.

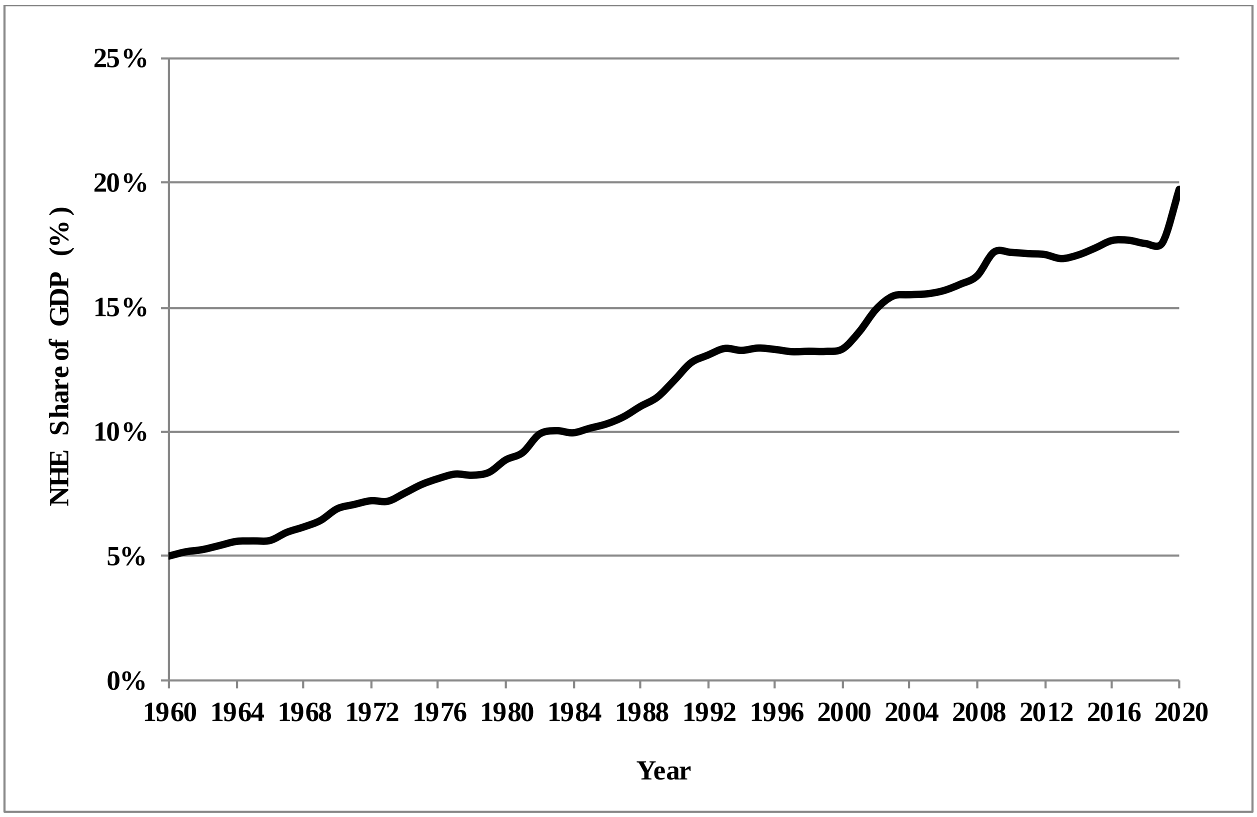
In general, long-term projections, which span 75 years beginning with a given current year, are made under an assumption that existing institutional arrangements and program parameters embodied in current law will prevail for the entire projection period. The 75-year current-law projection is intended to reflect a policy-neutral baseline that is useful for policy makers, researchers, health-care providers, beneficiaries, and others in considering the need for changes or adjustments in national policy.

The remarkable growth of the U.S. health sector as a share of the U.S. economy over the past six decades underscores the importance of understanding long-term trends for the Medicare program. From 1960 through 2020, the U.S. health sector share of the Gross Domestic Product (GDP) has grown from 5 percent to 19.7 percent (see chart 1 below), and over approximately the same time

[1] See "The Long-Term Projection Assumptions and Aggregate National Health Expenditures" (April 22, 2020) at https://www.cms.gov/files/document/long-term-projection-assumptions-medicare-and-aggregate-national-health-expenditures.pdf and "The Long-Term Projection Assumptions and Aggregate National Health Expenditures" (May 12, 2009) at http://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/ReportsTrustFunds/Downloads/ProjectionMethodology.pdf

frame the Medicare program has grown from less than 1 percent of GDP to 4 percent of GDP. In 2020, the U.S health sector share of GDP increased by almost 10 percent, an increase equal to more than 2 percent of GDP. In part the growth in the health sector's share of GDP was the result of the government's vigorous fiscal response to the COVID-19 pandemic with funding for new programs such as the Paycheck Protection Program and the Provider Relief Fund, increased funding for already existing programs in the area of public health, and higher federal Medicaid matching payments. The shrinkage in the level of total GDP in 2020 further magnified the growth in the size of the health sector relative to the entire economy. The upshot of all these factors was the largest single year recorded increase in the U.S. health sector share of GDP.[2]

Chart 1—National Health Expenditures as a Percentage of Gross Domestic Product, 1960–2020



Source: Centers for Medicare & Medicaid Services, Office of the Actuary

Central to OACT's long-term projections is a concept known as excess cost growth, which reflects whether health costs are growing or are likely to grow at rates that would further increase the sector's share of GDP. Excess cost growth is the difference between (i) the U.S. per capita growth

[2] It is expected that the cessation of temporary programs and revival of the rest of the economy will lead to some reduction in the health sector share from its 2020 level, but still above its 2019 level of 17.6%.

rate in health-care costs adjusted for demographic factors[3] and (ii) the per capita growth rate in GDP (both in constant dollars). Table 1 below provides a historical perspective on excess cost growth for the U.S. over various time periods since 1975. The values displayed in the table indicate an overall deceleration between the 2010 and 2015 with excess cost growth on average close to zero, a trend which in fact continued until just before the COVID-19 pandemic. Whether the slower rates of excess cost growth that prevailed immediately before the COVID health crisis will reassert themselves is uncertain. In light of the massive health sector growth since 1960 the long-term projection methods described in succeeding sections of this memorandum assume a continuation of some level of excess cost growth into the distant future.

[3] These demographic factors account for the changing distribution of the population by age, gender, and time-to-death (TTD). More information on the TTD adjustment is available at https://www.cms.gov/files/document/incorporation-time-death-medicare-demographic-assumptions.pdf

Table 1—Compound Excess Cost Growth Rates, Selected Time Periods 1975–2020

Time period	Compound Constant-Dollar, Per Capita Growth Rates		
	NHE (rounded)	GDP (rounded)	Excess Cost (rounded)
Periods since 1975:			
through 1980 (5 years)	5.1%	2.7%	2.4%
through 1985 (10 years)	5.1%	2.5%	2.6%
through 1990 (15 years)	5.4%	2.5%	3.0%
through 1995 (20 years)	4.9%	2.2%	2.7%
through 2000 (25 years)	4.6%	2.4%	2.2%
through 2005 (30 years)	4.6%	2.3%	2.3%
through 2010 (35 years)	4.3%	2.0%	2.3%
through 2015 (40 years)	3.9%	1.9%	2.0%
through 2020 (45 years)	3.8%	1.7%	2.1%
Periods since 1980:			
through 1985 (5 years)	5.2%	2.3%	2.8%
through 1990 (10 years)	5.6%	2.3%	3.2%
through 1995 (15 years)	4.9%	2.0%	2.8%
through 2000 (20 years)	4.5%	2.3%	2.1%
through 2005 (25 years)	4.5%	2.2%	2.3%
through 2010 (30 years)	4.1%	1.8%	2.3%
through 2015 (35 years)	3.7%	1.8%	2.0%
through 2020 (40 years)	3.7%	1.6%	2.1%
Periods since 1985:			
through 1990 (5 years)	6.0%	2.3%	3.6%
through 1995 (10 years)	4.7%	1.9%	2.8%
through 2000 (15 years)	4.2%	2.3%	1.9%
through 2005 (20 years)	4.4%	2.2%	2.2%
through 2010 (25 years)	3.9%	1.7%	2.2%
through 2015 (30 years)	3.5%	1.7%	1.8%
through 2020 (35 years)	3.5%	1.5%	1.9%
Periods beginning with 1990:			
through 1995 (5 years)	3.5%	1.4%	2.1%
through 2000 (10 years)	3.4%	2.3%	1.0%
through 2005 (15 years)	3.8%	2.1%	1.7%
through 2010 (20 years)	3.4%	1.6%	1.8%
through 2015 (25 years)	3.0%	1.5%	1.5%
through 2020 (30 years)	2.9%	1.4%	1.5%
Periods since 1995:			
through 2000 (5 years)	3.2%	3.3%	-0.1%
through 2005 (10 years)	4.0%	2.4%	1.5%
through 2010 (15 years)	3.3%	1.6%	1.7%
through 2015 (20 years)	2.9%	1.6%	1.3%
through 2020 (25 years)	3.0%	1.4%	1.6%
Periods since 2000:			
through 2005 (5 years)	4.8%	1.6%	3.1%
through 2010 (10 years)	3.4%	0.8%	2.6%
through 2015 (15 years)	2.8%	1.0%	1.8%
through 2020 (20 years)	2.9%	0.9%	2.0%
Periods since 2005			
through 2010 (5 years)	2.1%	0.0%	2.0%
through 2015 (10 years)	1.8%	0.7%	1.1%
through 2020 (15 years)	2.3%	0.7%	1.6%
Periods since 2010			
through 2015 (5 years)	1.6%	1.4%	0.2%
through 2020 (10 years)	2.4%	1.0%	1.4%
Periods since 2015			
through 2020 (5 years)	3.2%	0.6%	2.6%

Note: NHE values were previously adjusted to remove demographic effects on cost growth.

Long-Range Projection Methods

As a preliminary matter, it is important to emphasize that the excess cost growth assumptions and methods described in this section generate the projections for only the last 51 years of the 75-year long-term projection period, or years 25 through 75. For years 1 through 10, OACT develops projections at the service level (for example, inpatient hospital services, physician services, or home health care) using assumptions about payment rate updates for each category of spending, changes in utilization of services, and changes in the intensity or average complexity of services, as described in detail in the Medicare Trustees Report. For years 11 through 24, OACT prepares projections based on partial excess cost growth—transitioning, on a time-weighted basis, (i) the excess cost growth rate implicit in the year 10 short-range projection and (ii) the long-range excess cost growth rates by Medicare Part A, Part B, and Part D that are expected in year 25.[4]

The application of long-range excess cost growth methods for the Medicare projections for years 25 to 75 of the 75-year period involves two distinct steps. First, based on the Trustees' macroeconomic, demographic, and relative medical price inflation assumptions, OACT projects excess cost growth rates for national health expenditures using the "factors contributing to growth" model (henceforth referred to as the *factors model*). The result of this step is a set of projected excess cost growth rates for years 25 to 75, which are generally used for the development of the Medicare illustrative alternative scenario projections that are described in more detail later. The second step involves the development of current-law long-range Medicare spending projections for each part of Medicare by substituting the current-law Medicare price update instead of the price assumption from the first step.

Step One: Obtaining Projected Excess Cost Growth Rates for National Health Expenditures

The factors model developed by OACT is used for projecting long-term real growth rates for U.S. national health spending based on empirical research that was first published in 2009.[5] The factors model projects growth in per capita national health spending as a function of five major drivers: income growth, relative medical price inflation, rates of change in insurance coverage, change in demographic composition of the population, and a residual.[6] The model consists of (i) a parameter for each factor that represents the sensitivity of health spending to a change in that factor (elasticity), based on OACT research,[7] and (ii) an assumption for growth in each factor based on

[4] For Part A, beginning with the 2021 Trustees Report, the rate transition is time-weighted between a year 10 rate and a year 25 rate, but it is implemented individually for the various services that make up Part A and then is aggregated by year in accordance with projected service shares. This refinement of the rate transition method accounts for the nonlinearity in the intermediate transition paths shown for Part A in charts 2 and 3.

[5] Smith, Sheila, Newhouse, Joseph P., and Freeland, Mark S. "Income, Insurance, and Technology: Why Does Health Spending Outpace Economic Growth?" *Health Affairs*, 28, no. 5 (2009): 1276–1284.

[6] The residual would capture any variation in health spending that is not explicitly explained by other variables in the model or by any measurement error. In the case of the factors model residual, the main factor not captured by the other model variables is the exogenous contribution of technological change on health care spending, as described in the 2009 OACT research.

[7] The parameters are effectually elasticities in that they reflect the change in per capita health spending based on a 1-percent change in the factor.

a combination of exogenous macroeconomic projections from the Social Security Administration and OACT projections for health-care-specific variables.

The two most critical model parameters are those that are associated with the change in income growth and relative medical price inflation (see Appendix).[8] The parameter that relates to income growth can be interpreted as an income-technology elasticity in that it represents the sensitivity of health care spending to economic growth and to the adoption and diffusion of new medical technologies in response to growth in economic resources. The parameter that relates to relative medical price inflation represents the sensitivity of consumers and purchasers in consuming health care as the price of that care increases relative to other goods and services. Over time these parameters are projected to change to capture the behavioral response of consumers as health care consumption accounts for a rising share of income and as the price of health care increases relative to non-health-care consumption.

Based on the year-by-year growth rates determined from the factors model, per capita national health spending, adjusted for demographics, is projected to grow at a rate of GDP plus 0.8 percent for 2046 (or a nominal rate of 4.3 percent), gradually declining to GDP plus 0.4 percent by 2095 (or a nominal rate of 4.1 percent). (See figure A.5 in the Appendix.)

Step Two: Determination of Long-Term Projected Excess Cost Growth Rates by Medicare Part A, Part B, and Part D

As previously noted, there are two sets of projections that are used to determine excess cost growth rates for each part of Medicare: projections prepared under current law and projections prepared under an illustrative alternative scenario. Current-law projections represent a scenario in which existing statutory provisions specific to Medicare remain in effect for the duration of the 75-year long-term projection period. These projections are used to evaluate the financial status of the program in the Medicare Trustees Report. Excess cost growth under current law has been slower than projected under the factors model because growth under current law assumes implementation of statutorily required Medicare price updates that are generally lower than the relative price assumptions that underly the factors model projections. On the other hand, the illustrative alternative scenario reflects Medicare spending growth that tracks projected growth rates for national health spending more closely than do current-law projections, in order to give readers of the Trustees Report a sense of the potential magnitude of the difference should certain statutory Medicare payment provisions not be fully implemented in all future years. Both current-law projections and the illustrative alternative scenario include compositional adjustments associated with the changing demographics of the Medicare population; these demographics have traditionally reflected changes by age and sex, but, starting with the 2020 Trustees Report, they also incorporate the effects related to Medicare beneficiaries' proximity to death—capturing, in turn, the changing life expectancy of this population over the projection period.[9]

[8] The Appendix contains a detailed description of the theory and parameterization of the factors model. In practice, the other three model variables—changing insurance coverage, demographic changes, and the residual—all have a relatively small impact on the factors model results.

[9] See footnote 4 above.

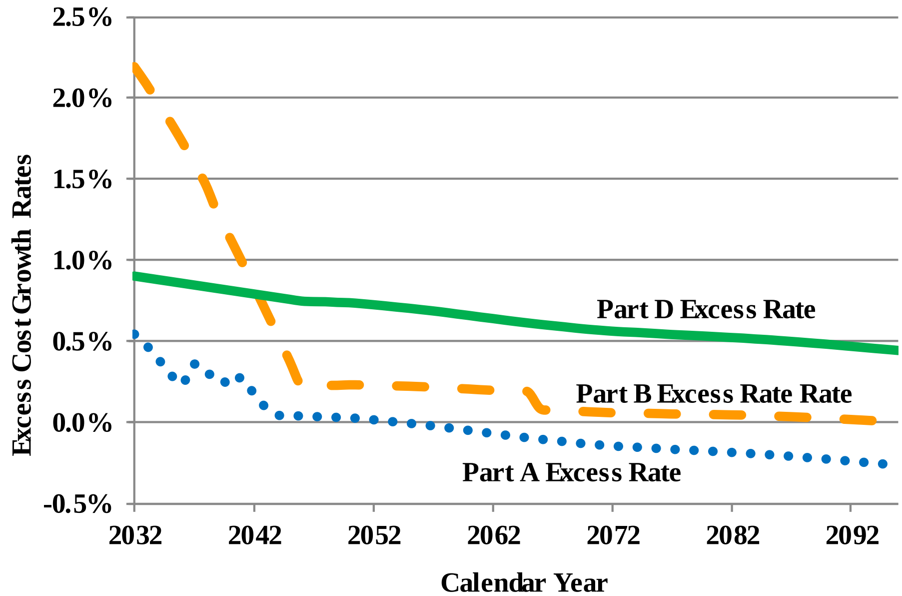
A. Current-Law Long-Term Medicare Spending

For each part of Medicare, the growth in the volume and intensity of care derived from the factors model is combined with the price update based on provisions in current law. For all Part A and some Part B services, the current-law price update reflects the relevant price measure (either the input price index for these services or the Consumer Price Index) reduced by the expected 10-year moving average of economy-wide multifactor productivity. The resulting current-law price update is lower than the price assumption assumed for national health expenditures in the factors model.[10] The price updates for Part B physician services depend on the payment model in which physicians elect to participate—0.75 percent per year for physicians participating in advanced alternative payment models and 0.25 percent per year for those participating in the merit-based incentive payment system. The update for all other Medicare services (Part D services and those under Part B for which specific statutory adjustments do not exist) is assumed to be consistent with the rates of overall health sector price growth assumed under the factors model.

Chart 2 shows year-by-year excess cost growth for Medicare Part A, Part B, and Part D under current law over the last 65 years of the projection period (2032–2096), including, for each part, both the 15-year transition of excess cost growth to the starting long-range values in 2047 and the gradually declining path thereafter. After 2046, the plotted excess cost growth rates for Parts A, B, and D have similar slopes because of shared assumptions that generate the underlying factors model projections, but the individual rates of growth reflect the specific statutory provisions affecting the payment updates for each part.

[10] Because of this difference, there is an additional –0.1-percent adjustment to the volume and intensity of care projections for national health expenditures based on the factors model, as recommended by the 2010–2011 Medicare Technical Review Panel. The Panel's report is available at https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/ReportsTrustFunds/Downloads/TechnicalPanelReport2010-2011.pdf

Chart 2—Medicare Projected Excess Cost Growth
Current Law, 2032–2096



Source: Centers for Medicare & Medicaid Services, Office of the Actuary

NOTE: Excess cost growth is the rate of change in per enrollee costs relative to the growth in per capita GDP. This chart displays projected long-term excess cost growth for Medicare Parts A, B, and D under current law. Each of the parts has its own unique series of excess cost growth through the end of the 75-year projection period due to the different applicable current-law payment provisions. The excess cost growth rates displayed here do not include additional spending changes that are attributable to demographic factors such as the age and gender composition of the Medicare population.

B. Illustrative Alternative Scenario

The Trustees Report cautions that current-law payment updates for Parts A and B might not be sustainable indefinitely and states: "In view of these issues with provider payment rates, the Trustees note that the actual future costs for Medicare could exceed those shown in this report." To help illustrate the level of Medicare costs that could result if those payment update provisions of current law were eventually overridden, the Trustees Report includes projections based on an alternative scenario.[11] These projections are shown in the 2022 Trustees Report and in a supplementary memorandum prepared by OACT. The illustrative alternative scenario assumes that there will be a gradual phase-out of productivity adjustments in the determination of payment updates over the intermediate projection term (years 11 through 24) and that over the long term

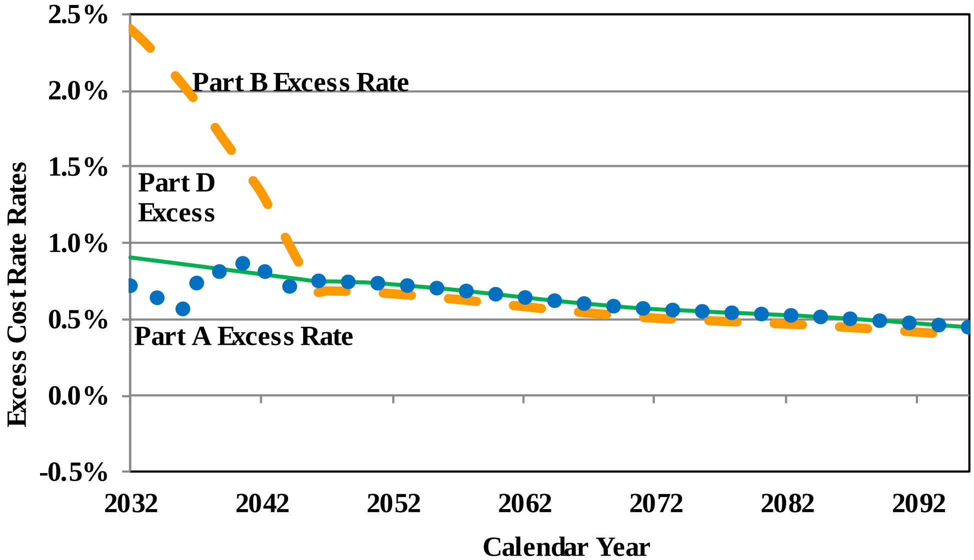
[11] More information on these concerns is available in Appendix C of the 2022 Medicare Trustees Report and in a memorandum by John Shatto and Kent Clemens of the Office of the Actuary titled "Projected Medicare Expenditures under Illustrative Scenarios with Alternative Payment Updates to Medicare Providers." These documents can be found at the following links: https://www.cms.gov/files/document/2022-medicare-trustees-report.pdf and https://www.cms.gov/files/document/illustrative-alternative-scenario-2022.pdf

(years 25 through 75) payment updates will be consistent with price growth projected under the factors model for the entire U.S. health sector.[12]

Chart 3 shows the assumed year-by-year excess cost growth for Medicare Part A, Part B, and Part D over the last 65 years of the long-range projection period under the illustrative alternative scenario. Under this scenario, beginning with the period 2032-2046, per beneficiary cost growth for most of Medicare is assumed to transition to an approximately common set of growth rate projections based on the factors model for overall per capita national health expenditures.[13]

For Part D, the excess cost growth rates that are shown in chart 3 under the illustrative alternative are the same as the rates that are shown in chart 2 under current law. For Parts A and B, however, the growth rates under the illustrative alternative scenario are higher than under current law, and, starting in 2046, the projected excess cost growth rates for Parts A and B generally coincide with those for Part D.

Chart 3—Medicare Projected Excess Cost Growth
Illustrative Alternative, 2032–2096



Source: Centers for Medicare & Medicaid Services, Office of the Actuary

NOTE: Excess cost growth is the rate of change in per enrollee costs relative to the growth in per capita GDP. This chart displays projected long-term excess cost growth for Medicare Parts A, B, and D under the illustrative alternative. Under this scenario, each of the parts converges to a similar rate of excess cost growth through the end of the 75-year projection period. The excess cost growth rates shown here do not include additional spending changes attributable to factors such as the age and gender composition of the Medicare population.

[12] Readers should not infer any endorsement of this theoretical alternative to current law by the Trustees, CMS, or the Office of the Actuary. However, concern about the long-term feasibility of the adjustments makes it advisable to consider the effects on the Medicare program should the payment update provisions of current law not prove feasible in the very long run.

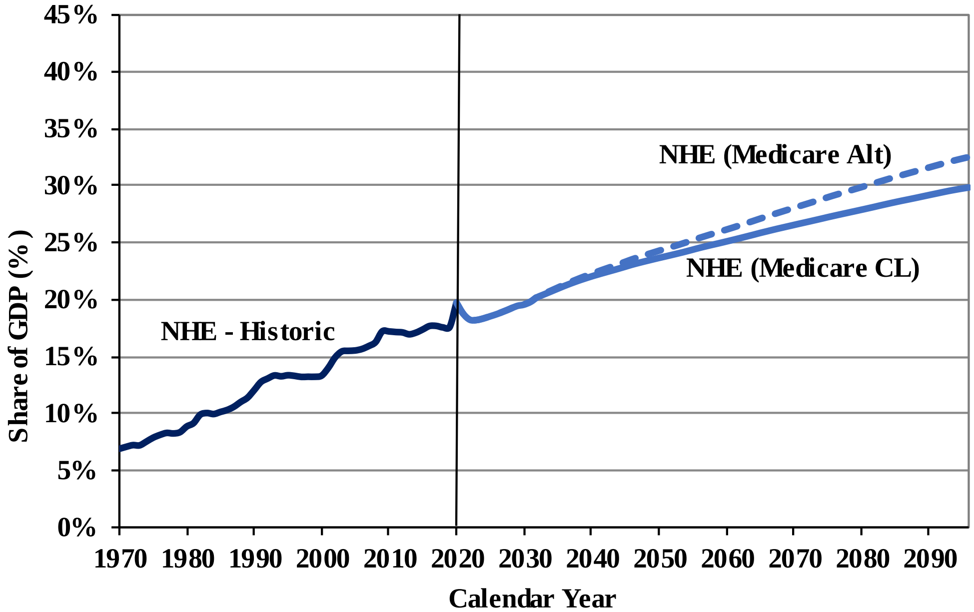
[13] The one exception is Part B services updated by the Consumer Price Index, which are assumed to have the same volume and intensity growth as national health expenditures but a lower price update, since Part B services are not updated based on the market basket.

History and Reasonability of Long-Range Medicare Spending Projections

Enactment of the Affordable Care Act in 2010 introduced payment update formulas varying generally by each part of Medicare. As a result of this variation in formula, important adjustments in projection methods were required because it was no longer feasible to produce a long-term current-law projection based upon application of a set of program-wide excess cost growth rate assumptions. Beginning with the 2013 Trustees Report, the factors model has been used as the starting point for developing the long-range projections, an approach supported by the 2010–2011 Medicare Technical Review Panel. This Panel also recommended that projections be prepared under an illustrative alternative scenario because of uncertainty concerning the long-term sustainability of new current-law payment update provisions. The illustrative alternative is intended to provide insight regarding the level of Medicare spending that could occur if the payment updates to providers that are specified under current law were less than fully implemented. The 2016–2017 Medicare Technical Review Panel affirmed the long-term projection methods described in this memorandum, which continue to be followed to the present day.

Chart 4 shows that historical growth of the U.S. health sector has experienced some volatility, but the long-term trend over the decades has been generally upward. As the chart also shows, for the national health expenditure (NHE) share of GDP, the long-term projections based upon the factors model assume a long-term continuation of the historical trend, regardless of whether the projections are prepared under current law or under the illustrative alternative scenario. Both sets of projections assume that the U.S. population will continue to prefer to spend more on health care over time. As previously discussed in this memorandum, the projections envisions a near-term reduction in the health sector share of GDP as the effects of the pandemic recede.

Chart 4—National Health Expenditures as a Percent of GDP, 1970–2096

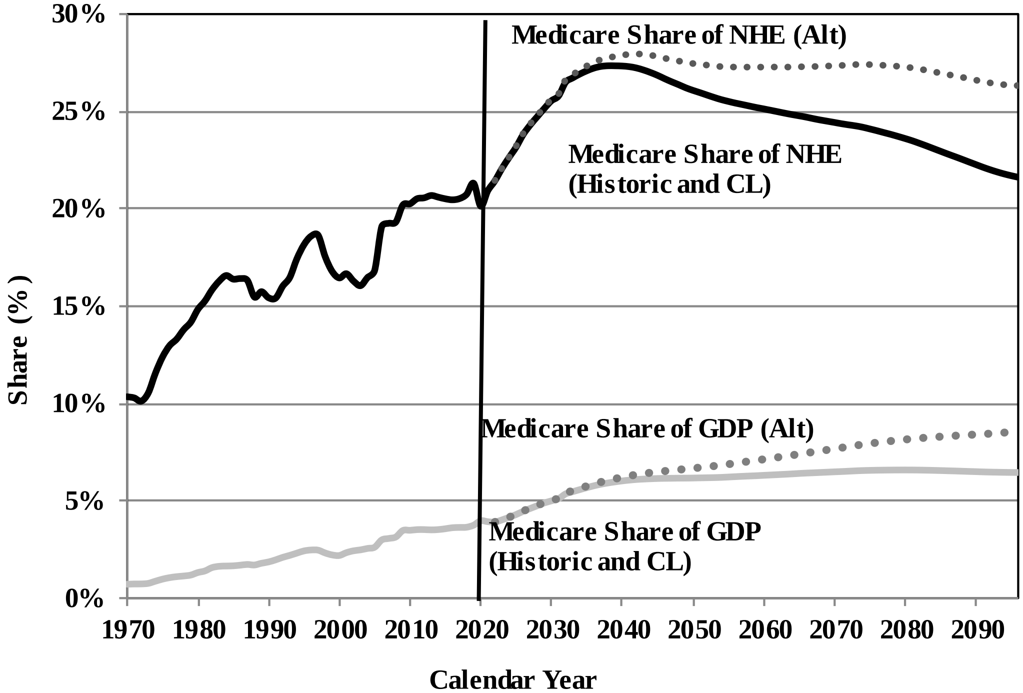


Source: Centers for Medicare & Medicaid Services, Office of the Actuary

NOTE: Historical data were used before 2021, and projections were used from 2021 onward.

Chart 5 illustrates differences between the two sets of long-term Medicare projections with regard to their respective projected shares of both national health expenditures and GDP. Under current law, Medicare's share of national health expenditures and GDP is projected to continue growing until the late 2030s as the share of beneficiaries of the overall population continues to increase; from 2040 onward, the effects of current-law payment update provisions specific to Medicare Parts A and B are expected to erode Medicare's share of overall national health expenditures, resulting in stabilization of this share. Under the illustrative alternative, Medicare's share of GDP continues to grow, but it eventually stabilizes as a share of national health expenditures because of expected stabilization in the Medicare-enrolled population as a share of the total U.S. population.

Chart 5—Medicare as a Percentage Share of GDP and of National Health Expenditures Historically and under Current Law and the Illustrative Alternative Scenario, 1970–2096



Source: Centers for Medicare & Medicaid Services, Office of the Actuary

NOTE: For the Medicare Share of GDP historical data is used before 2021 and projections from 2021 forward. For the Medicare Share of NHE, historical data is used before 2021 and projections from 2021 forward. Comparative illustrative alternative (Alt) projection results are shown by means of the dotted lines.

The Trustees are required by law to produce long-term current-law projections as a basis for evaluating the financial status of the Medicare program. It should be noted that projections over such a long-range period are subject to significant uncertainty and could change significantly as more information becomes available. The projections prepared under current law reflect the impact that important payment provisions have on expectations regarding the evolution and growth of the U.S. health sector. The illustrative alternative demonstrates for policy makers what the effect on the Medicare program could be if current-law payment provisions were to prove infeasible in the long run while access to care for Medicare beneficiaries was preserved.

Conclusion

The long-range cost growth assumptions have evolved through regular processes of expert review and evaluation, and improvements, refinements, and alternative approaches to the projection method continue to be considered. In their present form, the long-range assumptions under current law and under the illustrative alternative scenario lead to Medicare projections that provide a sound basis for evaluating long-range fiscal challenges to the Medicare program.

Appendix: Factors Contributing to Growth Model

The Office of the Actuary's "factors contributing to growth" model is an accounting framework that is used to track the historical contribution of factors that drive national health expenditure (NHE) growth and to develop projections of health care spending that are consistent with the evolution of these factors. The model relies on a wide range of empirical research as the basis for historical parameter estimates that reflect the sensitivity of health care spending growth to changes in each of the factors. Where the projected path for these parameters is expected to differ from historical patterns, the assumptions are adjusted to reflect the expected shift. These parameters are applied to projected growth in macroeconomic and health-care-specific variables to determine growth in national health spending over the long-term projection.

This appendix discusses the underlying structure of the factors model. Next, it provides a detailed discussion of the historical derivation of the key parameters in the model and presents the historical fit of the model during the period 1965–2019.[14] We note that data and relationships for the most recent data point in 2020 are strongly impacted by the effects of COVID and are therefore excluded from the estimation of all parameters (which are estimated only using data through the year 2019).

Finally, this appendix discusses how the factors model is used as the framework for developing long-range projections of national health spending growth that were used in the 2022 Medicare Trustees Report.

1. Factors Model Structure

Basic factors model equation

There are five key factors that have been identified to influence growth in aggregate per capita growth in national health expenditures:[15]

- demographics (the impact of distributional shifts across age and gender cohorts and proximity to death)[16];
- changes in insurance coverage;
- relative medical price inflation;
- changes in aggregate real per capita income; and
- a residual factor attributed primarily to the development and diffusion of new medical technologies.[17]

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[14] Due to the COVID-19 pandemic, 2020 was not included in the historical estimation sample.

[15] Smith, Sheila, Newhouse, Joseph P., and Freeland, Mark S. "Income, Insurance, and Technology: Why Does Health Spending Outpace Economic Growth?" *Health Affairs*, 28, no. 5 (2009): 1276–1284.

[16] These demographic factors, reflecting the changing distribution of the population by age and gender, also account for the changing distribution of the population by time-to-death for the projections in the 2022 report. More information on the time-to-death adjustment is available at https://www.cms.gov/files/document/incorporation-time-death-medicare-demographic-assumptions.pdf

[17] The residual captures the effect of all factors contributing to growth that are not specifically incorporated. The majority of such factors cannot reasonably be assumed to influence growth rates over extended periods of time. A broad consensus holds that technological change is the most critical factor that generates growth in health care spending sustained at rates above what would be predicted based on other key factors contributing to growth.

Below we discuss two versions of the factors model equation. In the basic form of the model, the role of each factor contributing to growth is represented separately with all other factors held constant. This version of the model is shown in equation (1) below.

The current version of the model, which is shown in equation (2), is a modified variant of this basic equation. The model equation is adjusted to split the contribution to spending growth from medical technology between an endogenous effect that occurs as a function of income and an exogenous effect within the model residual that captures the pure effect of the expansion of feasible options for medical treatment with all other variables held constant.

The structure of the basic version of the factors model is shown in equation (1) below:

$$(1)\quad h_t = a_t + \varepsilon_y\, y_t + \varepsilon_i\, i_t + (1 + \varepsilon_p)\, p_t + d_t$$

where each factor is expressed as a log difference (growth rate) and all spending series are in constant dollar terms based on the GDP deflator. Model variables are defined below:

h_t = constant dollar health spending per capita at time t
a_t = residual factor (primarily attributed to spending on new medical technology)
y_t = income at time t (GDP per capita)
i_t = average coinsurance rates at time t (out-of-pocket share of total health spending)
p_t = relative medical price at time t (relative to GDP deflator)
d_t = index of demographic contribution to health care spending at time t

Model parameters are defined as *elasticities*. Each elasticity represents an estimate of the percentage change in real per capita national health spending that results from a 1-percentage-point increase in the model variable in question. These elasticities capture the sensitivity of health care spending growth to changes in each of the causal factors. The elasticity associated with the index of health care spending growth due to changes in the demographic composition of the population is equal to one by construction (and is therefore not shown).

ε_y = income elasticity
ε_i = coinsurance elasticity
ε_p = health care price elasticity

Note that growth in relative medical prices affects health spending in two ways in this model. First, there is the direct impact of higher prices causing higher spending, other things being equal. In addition, however, there is a partial offset to this effect as higher prices for medical services tend to reduce demand somewhat, and this effect is reflected in the $\varepsilon_p \cdot p$ term in equation (1) above (where ε_p is negative).

The contribution of technological change to health care spending, primarily reflected as *a* in equation (1), is defined as the incremental spending on treatment methods within the period associated with new medical technologies. This effect will reflect both the relative utilization of new technology and its relative price in comparison with existing forms of treatment. Effects on spending associated with technological change can be expected to occur with a substantial lag following the development of new treatment options, with the impact on spending extending from the initial availability of the treatment through the process of adoption, followed by a transition to a new equilibrium (in the absence of changes in other variables).

The basic factors model, as presented in equation (1), is a simple reduced-form model that assumes that the contribution of each of the factors to health spending growth is independent of all of the others. This use of a reduced-form equation effectively represents a summary of the observed relationships in the aggregate data between health care spending growth and the net effect of growth attributable to a range of factors on both the demand and supply side. Equation (1) assumes that there will be no interaction effects among causal variables; the effect of each factor is assumed to be independent of all others.

This basic version of the factors model requires that each of parameters in the model be estimated empirically while holding all other factors constant. This method implicitly assumes that it is possible to accurately control for variation in these factors. In the case of medical technology, however, variation can be expected to occur in relation to the other factors, but it is not feasible to directly measure or control for all these potential interaction effects over time. Attempts to control for interaction effects between technology and other model variables therefore typically utilize a proxy, such as a time trend, to control for the effects of medical technology and its interaction with other variables.[18]

The most important of these interaction effects is the relationship between changing medical technology and aggregate income. Aggregate income is the key constraint on budgets for health care spending and thus has a strong effect on the adoption of new technology. A complicating factor with the time-trend proxy-based method arises with aggregate income, because estimating the relationship between health care spending and income in a model that includes a time trend as a proxy for technology potentially excludes a substantial part of the relationship between health care spending and income from the elasticity that applies to income. Given the importance of this interaction effect, the factors model equation was modified to explicitly account for the interaction between aggregate income and medical technology, as described below.

To the extent that it is not possible to control for interaction effects between the individual factors contributing to growth, or where there are additional factors contributing to growth that are not specified, the net impact of interactions and omissions on variation in health expenditure growth will be captured in the contribution to growth from the residual term (a_t).

Modified factors model equation

The basic factors model, shown in equation (1), implicitly captures both endogenous and exogenous contributions from medical technology in the residual, a_t.[19] Under the basic factors model, the full contribution of technology to spending growth would be projected forward using a time trend as a proxy for technological change. This approach implies that the full contribution from technological change to health care spending growth will remain constant over time, with

[18] Parameter estimates that attempt to hold technology constant generally rely on proxies—either a time trend or some related variable such as patents or research expenditures.

[19] Technical Review Panel on the Medicare Trustees Reports, *Review of Assumptions and Methods of the Medicare Trustees' Financial Projections*, Centers for Medicare & Medicaid Services (formerly Health Care Financing Administration), December 2000.

respect to the other factors, and will remain consistent with the historical contribution to growth—even as the resources to pay for this care vary and as future increases in the health share of aggregate income predictably strain budget constraints. If the contribution of technological change varies as a function of income, this representation will fail to capture an important factor contributing to growth. To capture this effect, we define changes in spending on new medical technologies that occur in response to changes in income as the income-technology interaction effect and modify the factors model equation to explicitly project these effects.

The modified factors model shown in equation (2) below addresses the issue of the interrelationship between income and medical technology. We separately estimate the elasticity that captures the relationship between health care spending and real per capita GDP (as a proxy for average income) to capture the endogenous contribution from technological change. The estimation of this modified income-technology elasticity is discussed in detail in the section below. After incorporating this new income-technology elasticity into equation (2), the resulting residual then encompasses the exogenous contribution to growth from technological change (as well as the effects of all omitted variables and measurement error).

$$(2)\ \ h_t = a'_t + \varepsilon'_y y_t + \varepsilon_i i_t + (1 + \varepsilon_p)\, p_t + d_t$$

where ε'_y is defined as the combined income-technology elasticity. It is equal to $\varepsilon_y + a(y_t)$ from equation (1), where $a(y_t)$ is variation in the residual that can be explained as a function of real per capita GDP. The estimation of ε'_y is discussed below. The modified residual a'_t is defined to capture both changes in the state of medical knowledge that are independent of variation in income, as well as the net effect of measurement issues and omissions. Ultimately, the modified factors model in equation (2) is the final version of the factors model and is the basis for the projection of growth rates for the long-range projection for the Trustees Report.

A substantial part of the explanatory power of the factors model for growth in national health spending per capita relies on the relationship to aggregate income. This can broadly be understood as the responsiveness of health spending to budget constraints. One part of such responsiveness to budget constraints can be conceptualized as endogenous institutional change. Institutional change is one form of mediating mechanism that allows health care spending to respond to changes in real per capita GDP that define the budget constraint above the out-of-pocket threshold where the effective price to the consumer is at or close to zero. Historically, much of this institutional change involves changes in the nature of insurance coverage and payment methods that alter the incentives facing providers and thus influence both utilization and spending. Thus, to the extent that institutional cost-saving spillovers from care management initiatives in the commercial market (including Medicare Advantage) influence traditional Medicare spending, this effect can be seen as a form of endogenous institutional change. This effect will be implicitly captured in the income-technology parameter of the modified factors model.[20] In addition, we would expect part of this institutional effect to also be captured in the residual from the factors model, to the extent that advancement in medical knowledge is a function of the nature of institutions.

[20] For a discussion of treatment of spillover effects in the context of the factors model by the 2016 Medicare Technical Review Panel, see Frakt, Austin, "Medicare Advantage to Traditional Medicare Spillovers: Draft Recommendations,"", February 1, 2017 (https://aspe.hhs.gov)

2. Estimation of Factors Model Parameters

Income-technology elasticity

Current OACT research on the income-technology elasticity implies that the combined contribution of income and new medical technology accounts for an estimated 71 percent of constant dollar per capita health spending growth over the period 1980–2019.[21] Thus, the elasticity of real per capita health care spending with respect to income and technological change is a critical parameter in the factors model.

Substantial empirical literature addresses the relationship between health care spending and real per capita GDP.[22] This relationship has long been recognized as a strong and consistent empirical regularity in cross-country time-series data. Variations in real per capita GDP across countries and time can predict a large part of the variation in real per capita health spending. Higher-income countries tend to introduce new technologies earlier and to encourage broad diffusion into standards of medical practice.[23] However, this literature does not generally treat technology as an endogenous factor contributing to growth in health care spending. Rather, in a plurality of studies that estimate an income elasticity, medical technology is assumed (implicitly or explicitly) to be an exogenous variable.[24] Most estimates of income elasticity at the aggregate level use pooled data across countries and time and commonly control for variation across both countries and time by including fixed effects (dummy variables) for each country and time period in the sample. Given that technology changes over time, but not across countries within a single time period, its effect is assumed to be subsumed within the estimated fixed effects by time period.

Equation (3) below shows a specification that is similar to those commonly used for the estimation of the aggregate income elasticity. Aggregate national spending on health care is represented as a function of real per capita GDP, and two-way fixed effects (dummy variables) that capture variation that is constant across all countries in the sample over time (time-period fixed effects) and variation that is constant for each country in the sample across all time period (country fixed effects).

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[21] This estimate is based on the mean estimate of the income-technology elasticity over the period 1980–2019, obtained using an extrapolation of the income-technology elasticity.

[22] Nghiem, S.H., and Connelly, L.B. "Convergence and determinants of health expenditures in OECD countries,'"', *Health Economics Review,* 2017, 7:29.

[23] Moïse, Pierre. "The Heart of the Health Care System: Summary of the Ischaemic Heart Disease Part of the OECD Ageing-Related Diseases Study," in *A Disease-based Comparison of Health Systems: What is Best and at What Cost?* Organisation for Economic Co-operation and Development, 2003: 27–52.

[24] This choice largely reflects the difficulty of defining a variable that represents the state of medical technology; while there have been attempts to develop a proxy for this concept (for example, R&D and patents), these proxies cannot address important issues such as the presence of long and variable lags in the relationship between R&D and health care spending, or the fact that many important innovations are not patented (for example, medical procedures).

$$(3)\quad \ln\left(\frac{\frac{h_t}{p_t}}{n_t}\right) = \alpha + \beta \ln\left(\frac{\frac{y_t}{p_t}}{n_t}\right) + \sum_{c=0}^{I} c_i + \sum_{t=0}^{T} z_t + \varepsilon_{it}$$

α = constant term
h_t = nominal health care spending converted to U.S. dollars based on purchasing power parities
y_t = nominal GDP converted to U.S. dollars based on purchasing power parities
p_t = GDP deflator
n_t = population
β = coefficient on real per capita income (income elasticity)
I = number of countries in pool
T = number of years in sample
z = fixed effect for each year t in the sample
c = fixed effect for each country i in the sample
ε_{it} = error term

Current estimates of the income-technology elasticity are based on a specification that is similar to equation 3 but with the difference that time period fixed effects are excluded from the model (see equation 4 below). The income-technology elasticity incorporated in the factors model is based on the estimation of equation (4) based on pooled cross-country time-series “Organization for Economic Co-operation and Development” (OECD) data for 20 countries.[25] Spending and income are defined in constant dollar per capita terms and deflated based on the GDP deflator. Currency conversion to U.S. dollars is based on purchasing power parities.[26]

$$(4)\quad \ln\left(\frac{\frac{h_{it}}{p_t}}{n_{it}}\right) = \alpha + \beta' \ln\left(\frac{\frac{y_{it}}{p_t}}{n_{it}}\right) + \textstyle\sum_{c=0}^{I} c_i + \varepsilon_{it}$$

h_t = nominal health care spending converted to U.S. dollars based on purchasing power parities
y_t= nominal GDP converted to U.S. dollars based on purchasing power parities
p_t = GDP deflator
n_t = population
α = constant term
β' = coefficient on real per capita income (income-technology elasticity)
I = number of countries in pool (20)
t = year
c = fixed effect for each country i in the sample
ε_{it} = error term

[25] Countries in the sample include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States.

[26] Source: Organization for Economic Co-operation and Development (2014), “*OECD Health Data*,” OECD Health Statistics (database).

The exclusion of fixed effects by time period in equation (4) effectively means that we assume that a shared time trend across the countries in our sample is acting as a proxy for technological change. Time-period fixed effects tend to be positively correlated with growth in real per capita GDP. This implies that the coefficient β' on real per capita GDP based on equation (4) is higher than the coefficient β from equation (3). The coefficient β' is conceptually comparable to the elasticity ε'_y from equation (2). The difference between β' and β is assumed to be attributable to a positive interaction effect between technological change and income growth.

Change in the income-technology elasticity over time

The income-technology elasticity is assumed to change over the projection interval, and the historical rate of change over time is estimated empirically. Accounting for potential changes in key model parameters is necessary in the factors model given the 75-year length of the projections. As the health share of the economy rises over time, sensitivities to changes in price and income are also anticipated to change.

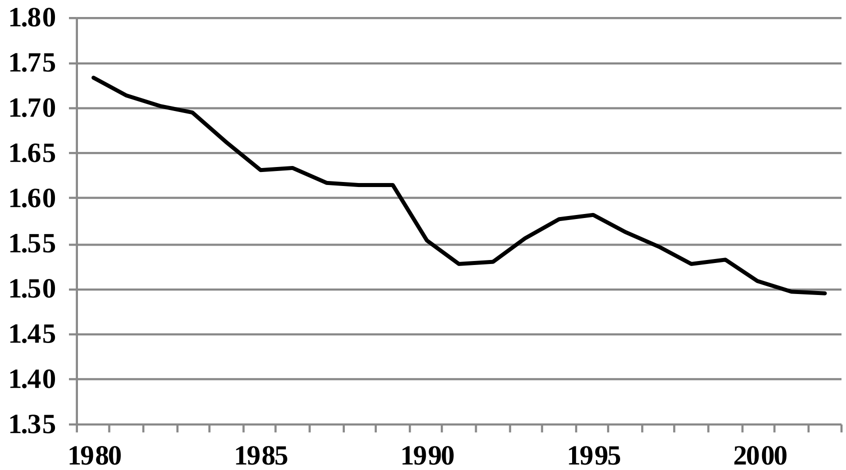
The change in the elasticity in the historical data is determined by estimating the model specification in equation (4) over a series of rolling 21-year sample intervals (within the full data sample).[27] The model in equation (4) was estimated for 21-year sample intervals, starting with 1970–1990, and incrementing the start and end date of the sample by a single year through the final sample interval of 1992–2012.[28] The estimated elasticity based on each of these sample intervals was attributed to the 11th year (the midpoint) of the 21-year sample, resulting in a time series for the income-technology elasticity for the period 1980–2002.

The results of this estimation show a systematic decline in the income-technology over the period 1970–2012. The rate at which the elasticity declines tends to slow down over time. The time-series shown in figure A.1 provides an estimate of the historical change in the income-technology elasticity over the period 1980–2002. This time series is used as the basis to evaluate the appropriate assumption for the income-technology elasticity over the 75-year projection interval. This strengthens the empirical basis for the long-term assumption for this parameter. However, a substantial degree of uncertainty continues to be associated with the projection, as the historical interval represented by the series (1970–2012) is fairly short in comparison with the projection interval (75 years) and the estimates remain at least somewhat sensitive to issues of data and sample selection. Conceptually, this downward trend captures, in part, the impacts on health spending associated with the influence on technology from endogenous institutional change.

[27] An alternative method of estimating change in the income-technology elasticity (β')would be to include an interaction term between β' and some function of a time trend. We chose to estimate the change in this parameter based on rolling regression to avoid imposing a functional form on the path of change. This becomes relevant when we consider the projection of the elasticity over the 75-year projection interval, as the difference between (for example) a liner and a log-linear time trend implies a large difference in the long-term assumption.

[28] Historical estimation of model parameters is updated at multiyear intervals to avoid frequent changes in model assumptions that could reflect temporary cyclical fluctuations in economic conditions.

Figure A.1.—Income-Technology Elasticity Estimates, 1980–2002



Relative medical price inflation

Data sources for medical prices are consistent with those used in the National Health Expenditure Accounts (NHEA).[29] The price measure for total personal health care spending is a chain-weighted deflator based on relevant Producer Price Indexes and Consumer Price Indexes, with the weight for each index set equal to the share of personal health care expenditures accounted for by that type of service.

The historical estimate of the aggregate price elasticity (−0.4) is based on the estimate in OACT's NHE projections model.[30] This elasticity exceeds the out-of-pocket price elasticity of −0.2 estimated based on the Rand Health Insurance Experiment (HIE).[31] This higher price elasticity at the aggregate level reflects the broader definition of the elasticity, which includes price sensitivity at the market level in addition to the price effects for households in response to variations in the effective out-of-pocket price that are the basis for the HIE elasticity. Additional price sensitivity occurs at the point of purchase of private health insurance and in the process of selective contracting by insurers acting as agents for consumers.

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[29] See documentation of historical NHE data, available at https://www.cms.gov/files/document/definitions-sources-and-methods.pdf

[30] Centers for Medicare & Medicaid Services. "Projections of national health expenditures: methodology and model specification." Available at http://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/Downloads/ProjectionsMethodology.pdf

[31] Manning, W.G., WG, Newhouse, Joseph P., JP, Duan, N.,, Keeler, E.B., and EB, Liebowitz, A. "Health insurance and the demand for medical care: evidence from a randomized experiment." American Economic *Review*, 77, no.3 (. *Am Econ* Rev. 1987): 251–257.

Insurance coverage

The effects of insurance are defined based on the aggregate average out-of-pocket share of health expenditures. This definition is conceptually consistent with the elasticity based on the Rand HIE (−0.2).[32] The estimation of this insurance elasticity was primarily cross-sectional based on variation in health care spending as a function of the generosity of insurance coverage across households at a point in time, so this elasticity effectively holds technology constant. This variable captures static effects of insurance coverage only. This effect would include the increased utilization of current medical technologies in response to reduced out-of-pocket price. However, this effect would exclude any dynamic effects of insurance coverage on the development of new medical technologies. Dynamic interaction effects between insurance and technology are in theory included in the residual (a'_t). There is also the potential for three-way interaction effects among the contributions of insurance with both income and technology effects that cannot be separated out based on our estimation methods. This suggests that some part of the dynamic effects of insurance coverage may also be captured in the income-technology contribution.

Demographic change

The current factors model accounts for demographic factors from the change in the composition of the population by age, gender, and proximity to death. These effects capture the impact of the changing distribution of the population by age, gender, as well as the composition of the population by proximity to death by age and gender cohort. The latter effect is referred to as a time-to-death (TTD) adjustment. [33] The TTD adjustment reflects the fact that the closer an individual is to death, the higher his or her health care spending is. As mortality rates improve and a smaller portion of the population is likely to die at any given age, the positive effect on spending of aging is partially offset, as people farther away from death exhibit per capita spending health spending that is lower.

The adjustment for the effects of shifts by TTD controls for variation in spending between survivors and decedents. The estimated effect for this population rests on a key assumption: that the base year spending in the final year of life for the under-65 population can be reasonably assumed to be equal to that for the youngest age cohort within the Medicare aged population (ages 65 to 69 years). This broad assumption rests on analysis by French et al. (2017) and is necessitated by the lack of specific data on the distribution of spending by TTD for the under-65 population in the U.S.[34]

The effects of shifts in the population across age, gender, and TTD cohorts are estimated based on the historical and projected population cohorts over time prepared by the SSA Office of the Chief Actuary on behalf of the Board of Trustees, combined with a base-year distribution of

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[32] Newhouse, Joseph P. J Health Insurance Experiment Group. *Free for All? Lessons from the RAND Health Insurance Experiment*. Cambridge (MA): Harvard University Press; 1993.

[33] More information on the time-to-death adjustment is available at https://www.cms.gov/files/document/incorporation-time-death-medicare-demographic-assumptions.pdf

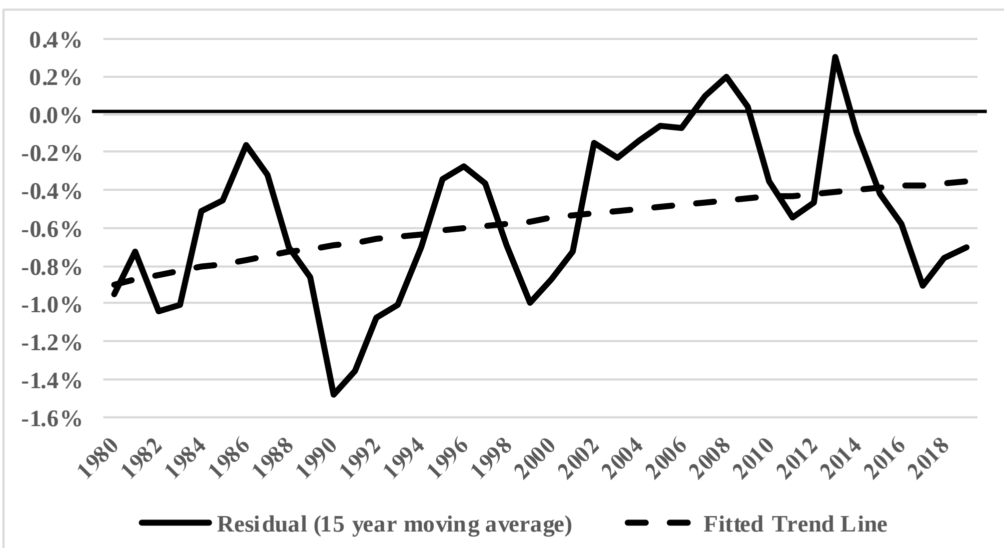
[34] French, E.,, McCauley, J.,, Aragon, M.,, Bakx, P.,, Chalkley, M.,, Chen, S.,, Christensen, B.,, et al. "End-of-life medical spending in last twelve months of life is lower than previously reported.". Health *Affairs* (Millwood). 2017; 36(7): 1211–1217.

expenditures across age and gender groups and Medicare program data for the population over 65 years of age. The application of base-year weights to projections of population cohorts produces an index of growth in health spending that will result from shifts across these cohorts.[35] This methodology assumes that the distribution of expenditures does not change over time in response to changes in the distribution of population across age, gender, and TTD cohorts.

Model residual

The factors model residual captures all variation that is not explicitly explained by other variables in the model. If all factors contributing to growth in health care spending are fully accounted for and accurately measured, then theory implies that the contribution from the residual should be equal to the exogenous effect on health care spending of technological change.[36] Even when every assumption is carefully considered and empirically based, a great deal of uncertainty is reflected in the residual, and the source and relative importance of this uncertainty are impossible to fully determine. Historically, the contribution to growth in real per capita national health expenditures from the modified factors model residual a'_t exhibits extreme volatility. We use a 15-year centered moving-average to smooth the time series so that we can better evaluate the path of this contribution over time (figure A.2. below).

Figure A.2.—Factors Model Residual with Fitted Trend Line, 1980–2019



35 *2022 Annual Report of the Boards of Trustees of the Federal Hospital Insurance and Federal Supplementary Medical Insurance Trust Funds,* https://www.cms.gov/files/document/2022-medicare-trustees-report.pdf

36 As a practical matter, measurement of the contribution to spending growth from other factors is unavoidably subject to error (both in underlying data and in model parameters), the effect of such errors, and the effects of any omitted variables. Consequently, such factors are thus also included in the residual.

Historical parameter assumptions

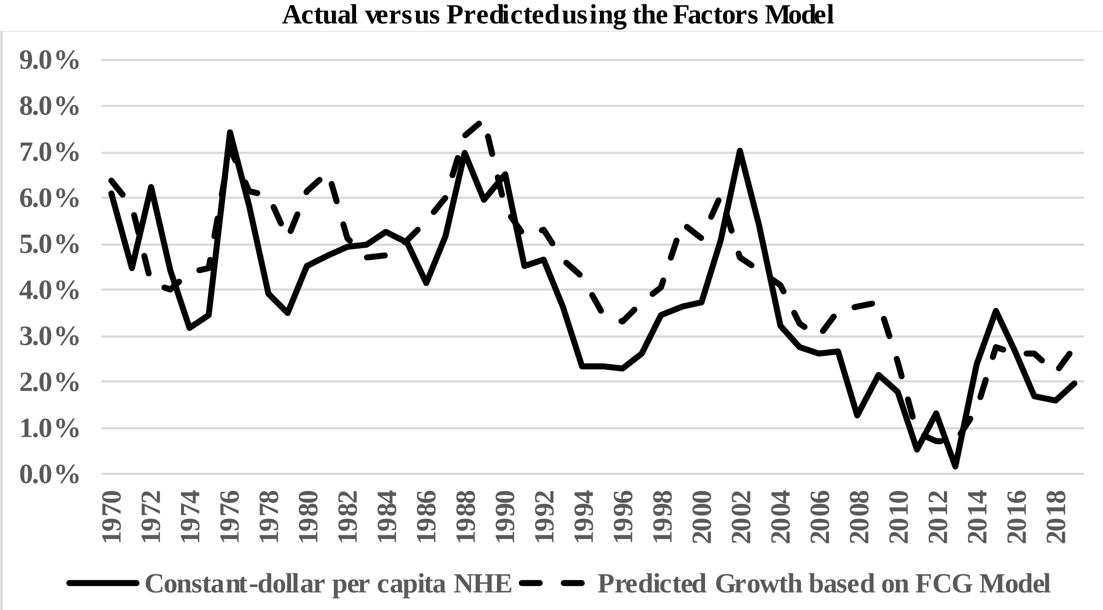
Table A.1.—Historical Elasticities Based on the Factors Model

	Equation (2) variable	Historical estimate
Income-technology elasticity	ε'_y	1.5–1.7
Insurance elasticity*	ε_i	−0.2
Relative medical price elasticity	ε_p	−0.4

*Reflects the static impact of insurance coverage.

Table A.1. shows the historical elasticity estimates that are used in equation (2) to explain a large part of historical growth in health spending over the period 1970–2019, as shown in figure A.3. below.[37]

Figure A.3.—Growth in Constant Dollar Per Capita National Health Expenditures, 1970–2019 Actual versus Predicted using the Factors Model



NOTE: The predicted values as shown in figure A.3. also control for a substantial lag in the relationship between health spending growth and income growth, by incorporating a 5-year moving average of growth in real per capita GDP. Figure A.3. is not directly comparable with figure A.2, because data shown in figure A.2. are based on a 15-year moving average, while data in figure A.3. are not.

3. Factors Model Long-Range Projections

Projections of health spending growth using the factors model should be consistent with historical relationships between growth in health spending and the individual factors contributing to growth. However, a simple extrapolation of the historical relationships over 1960–2019 implies an increase in the health share of spending that would ultimately absorb all available economic resources. In

[37] The predicted increases in real per capita health expenditures (figure A.3.) include the estimated contribution from a combined income-technology effect, relative medical price inflation, insurance coverage, and demographic change.

the long run, if the health share of consumption continues to rise along its historical trajectory, economic theory suggests that consumer preferences will adjust to slow the rate of increase in the health share of GDP. This predicted change in consumer preferences implies that the parameters in the factors model can be expected to change over time. Specifically, as health accounts for a rising share of consumption, we can expect to see rising sensitivity to relative medical prices (as represented by the price elasticity), and a declining tendency to further increase consumption of health care out of income at the margin (as represented by the income-technology elasticity).

In the discussion below we present the factors model parameter assumptions over the projection period, the exogenous parameter assumptions used to develop the factors model projections, and the results from the factors model that were used in the 2022 Trustees Report.

Factors model parameter assumptions

The elasticity assumptions in the factors model determine the sensitivity of national health care expenditures to changes in each factor for the projection in the long term (defined here as years 25 through 75 of the 75-year projection). As described above, economic theory suggests that as the health share of consumption rises substantially over the long term, the elasticities that represent consumer preferences can be expected to change (see table A.2. below). Specifically, we can expect consumers to become increasingly sensitive to the relative price of goods that account for a growing share of total consumption (implying a rising magnitude in the price elasticity). We can also expect to see a decline in the income-technology elasticity over time. An income-technology elasticity greater than one means that health spending will grow faster than GDP, in the absence of a change in other factors (such as price). Though the historical income-technology elasticity is estimated to be well above one, we can expect this parameter to gradually decline to one in a long-term equilibrium state so that non-health consumption is not crowded out by the continued rise in the health share.

Table A.2. below provides a summary of the key elasticity assumptions used for the factors model in generating the growth in national health expenditures applied in the 2022 Trustees Report.

Table A.2.—Elasticity Assumptions for Factors Model, 2046–2096

Income-technology elasticity (ε'_y)	Insurance Elasticity (ε_i)	Price elasticity (ε_p)
1.24 → 1.07	−0.2	−0.50 → −0.56

Income-technology elasticity assumption

To develop this assumption, we estimated the change in the historical income-technology elasticity over time based on cross-country time-series data from the OECD (as discussed above).[38] The resulting historical time series was then projected forward over the 75-year projection interval. A

[38] Source: Organization for Economic Co-operation and Development (2014), "*OECD Health Data,*" OECD Health Statistics (database).

log-linear trend was fitted to the historical time series of the income-technology elasticity estimates as shown in equation (5) below.[39]

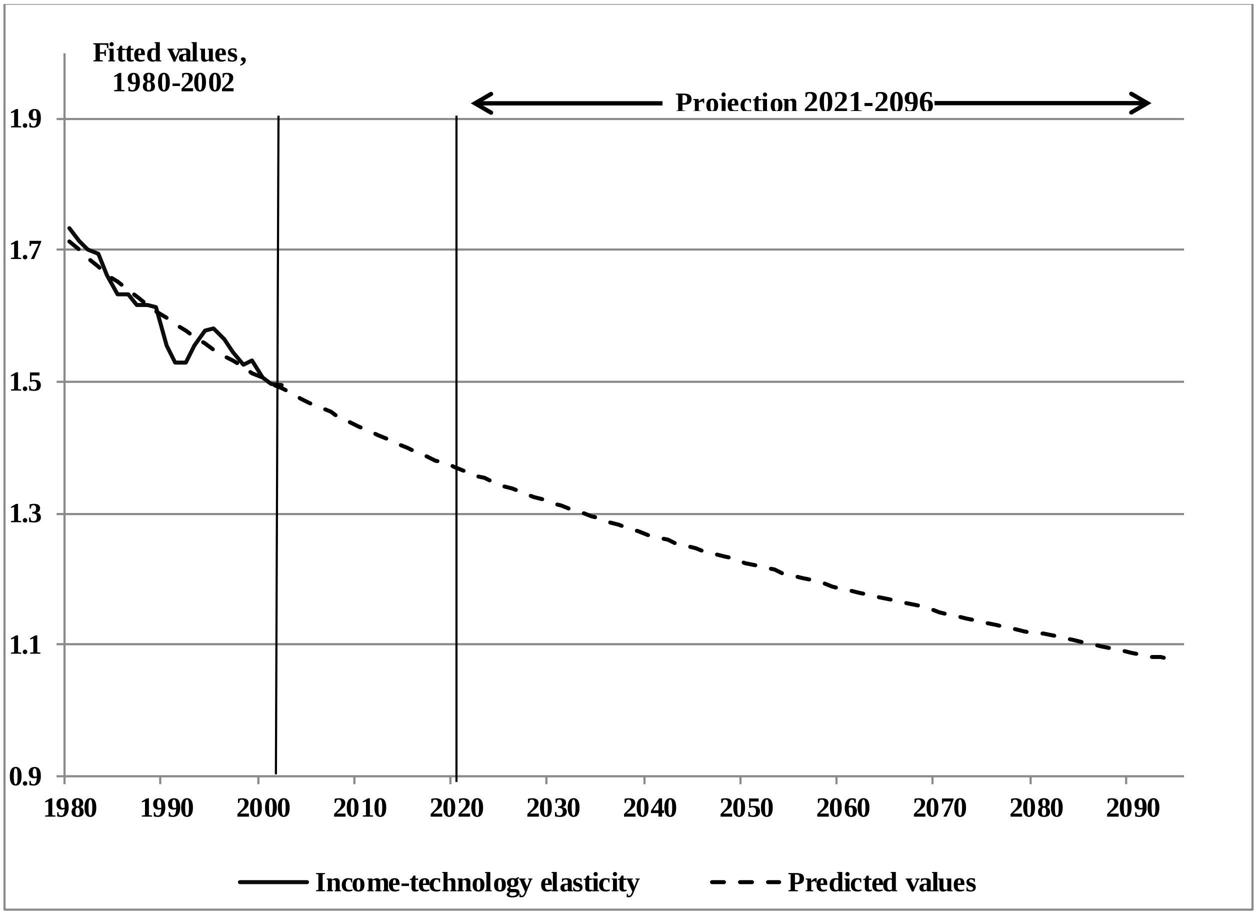
(5) $$\beta_t = \gamma + \delta' \ln(\text{TREND}(b)) + \varepsilon_t$$

TREND(b) = time trend such that TREND(b)=1, TREND(b+n) = 1+n, for n=1….30
b = base year for time trend
β_t = Income-technology elasticity estimates based on the rolling regressions with midpoint t
t = year representing the sample midpoint from the rolling regressions (t=1980….2002)
γ = constant term
δ = coefficient on trend variable

The resulting actual versus predicted values for the income-technology elasticity, with the projection based on this model are shown below in figure A.4.

[39] The use of a log-based time trend was selected following evaluation of alternative functional forms. The choice of a log-form implies that the rate of change in the income-technology elasticity will tend to slow over time. This pattern of change was consistent with the estimated historical time-series for the income-elasticity, and also tended to produce a more reasonable projection that levels out near a value of 1.0 in the long term. In comparison, a linear time trend implies a constant rate of decline that ultimately reaches zero unreasonably fast (much sooner than the end of the 75-year projection).

Figure A.4.—Income-Technology Elasticity Estimates: Historical Estimates and Projections



Price elasticity assumptions

The price elasticity of demand for health care (ε_p) is inelastic over the history (estimated at −0.4), meaning that a 1-percentage-point increase in medical prices relative to economy-wide prices is associated with a −0.4-percentage-point reduction in real health care consumption. This also implies that the net impact of medical prices rising faster than economy-wide inflation on nominal health care spending growth is positive. Over the long term, medical prices are projected to continue to grow faster than economy-wide prices, although the differential is expected to be smaller than has been the case historically. However, as discussed earlier, the magnitude of the price elasticity is expected to increase (in absolute value) as the share of consumption allocated to health care rises over time.[40]

The rationale for the increase in consumer price sensitivity (or magnitude of the price elasticity) implies that the price elasticity will be a function of the health share of GDP. This relationship is derived from the Slutsky equation (see box 1). Within the factors model, this means that the price

[40] Silberberg, Eugene, *The Structure of Economics: A Mathematical Analysis*, McGraw-Hill, 2000.

elasticity is endogenously determined, since the health share of GDP is a function of all of the parameter assumption in equation (2). The effects of this endogeneity have been explicitly incorporated in the model.[41]

Box 1: Projecting the price elasticity of demand for health care as the health share of consumption rises

The Slutsky equation (in elasticity form) is an identity that decomposes the price elasticity into two components: a pure substitution effect and an income effect. The pure substitution effect is not observed—it is the change in demand in response to a change in the relative price of health care holding utility constant. The income effect occurs because a rise in price implies a lower income. That is, the greater the share of health care out of total consumption, and the higher the income elasticity, the larger will be the income component of the price effect:

$$\varepsilon_p = \varepsilon_p^c - s_h \varepsilon_y'$$

where ε_p is the observed price elasticity, ε_p^c is the compensated price elasticty (or pure substitution effect), s_h is the health spending share of total consumption, and ε_y' is the income-technology elasticity.

Given assumptions of price and income elasticities and historical data on the health share of consumption, we can back out the unobserved pure substitution effect (compensated price elasticity). If in 2019 the observed price elasticity is −0.4, the income-technology elasticity (including interaction effects) is 1.4, and the health share of GDP is 18 percent, then the compensated price elasticity is estimated at −0.2 (calculated as −0.4 + 0.18×1.4).

We assume that the compensated elasticity remains constant at −0.2 over time as the pure substitution effect is not affected as the health share of consumption changes. We can combine this constant with preliminary projections for the health share of consumption and the assumed income-technology elasticity over time to impute the rise in the total price elasticity that is consistent with the rising share of health care spending.

Note that the health share of GDP will be influenced by the projected price elasticity. This means that the system will be simultaneous by nature. However, we can approach an answer that is fairly stable by iterating between the projections based on the factors model and the relationship between elasticities in the Slutsky equation. The resulting estimate for the price elasticity (ε_p) in year 75 is −0.6 (which is determined by −0.6 = −0.2 − 0.33×1.07), as shown in table A.2.[42]

[41] The endogeneity of the price elasticity and the health share of GDP effectively require a simultaneous model solution. We approximate this result by solving the model iteratively for the price elasticity and the health share, and then resolving the model until both concepts converge to an internally consistent solution.

[42] The price elasticity estimate is calculated using the health spending projections that incorporate the illustrative alternative scenario Medicare projections.

Factors model residual assumptions

The residual expenditure growth (a'_t) estimated from the historical predictions of the modified factors model in equation (2) is highly volatile. The mean for this residual series has a value less than zero over the 1980–2019 period, but exhibits an upward trend.

Though the historical residual makes a negative contribution to spending growth, empirical case-study evidence implies a probable positive impact on health care spending from new technology (based on the relative cost of new treatment options in comparison with previous best practice).[43] Thus the observed negative impact from the residual is believed to be attributable not to cost-decreasing technological change but to a combination of unavoidable measurement error and possible omitted variables in the model. On balance, the contribution to growth in health care from other factors included in the model may be overestimated (for example, measurement of medical price inflation is a probable issue).

The current assumption for the future contribution to growth from the factors model residual consists of two parts: an extrapolation of the historical contribution to growth over the short- to intermediate-term projection period (10 to 25 years), and an ultimate steady-state target contribution to growth that applies over the long-term projection period (26 to 75 years).

The extrapolation of the time-series reflects a log-linear trend fitted to historical data during 1980–2019. Though the mean contribution to growth in national health expenditures from the residual is a net negative, there is a positive trend in the residual. The projected contribution from the residual based on the fitted log-linear trend reaches zero within the intermediate projection period (between 10 and 25 years).

After the 25th year of the projection, the contribution of the residual to spending growth is assumed to be zero due to several factors. First, we cannot reasonably predict on an a priori basis whether new medical treatments developed in the future will tend to increase or decrease costs relative to existing treatment options. It is plausible that the nature of technological change (cost-increasing or cost-decreasing) could be a function of systemic factors, as innovators respond to incentives inherent in public and private insurance that influence expected returns on investment.[44] Collectively, empirical evidence suggests the exogenous component of technological change may be small, while theory suggests the future effects are unknown with incentives pushing in both the cost-increasing and cost-decreasing directions. Second, an extrapolation of the historical trend based on the observed residual throughout the 75-year projection would imply a positive contribution to growth over the long-term. Given that the historical contribution to growth is almost uniformly negative, such an extrapolation would suggest a higher level of confidence in the estimated trend than could reasonably by justified given the degree of uncertainty. Consequently, it seems reasonable to assume from both perspectives that the contribution to

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[43] Hult, K.J., Jaffe, S., and Philipson, T. J.. "How Does Technological Change Affect Quality-Adjusted Prices in Health Care? Systematic Evidence from Thousands of Innovations,", Working Paper Series: Health Economics Series. No. 2016–29.

[44] Weisbrod, B.A. "The Health Care Quadrilemma: An Essay on Technological Change, Insurance, Quality of Care, and Cost Containment," *Journal of Economic Literature*, June 1991, Vol. XXIX(2): 523 T. J. 552.

spending growth from the exogenous component of technological change may not be substantively different than zero.

Exogenous assumptions

The key economic assumptions for per capita GDP and the GDP deflator are based on the intermediate set of assumptions underlying the 2022 Social Security and Medicare Trustees Reports. The relative medical price inflation is determined based on long-range assumptions regarding growth in medical input prices and available evidence on achievable resource-based health sector productivity growth. As described in the main text of this memorandum, medical input prices are assumed to grow at roughly 3.2 percent per year. The GDP deflator is assumed to grow at 2.05 percent per year over the long run. Overall resource-based health sector productivity is assumed to grow at 0.4 percent per year by assuming hospital and physician productivity will grow at published historical rates (0.4 percent and 1.0 percent, respectively),[45] while all other provider categories, such as skilled nursing facilities, home health agencies, hospices, diagnostic laboratories, dialysis centers, and ambulance companies, will grow at zero, on average. Combining these assumptions produces a medical output price increase of 2.8 percent per year, which is 0.75 percentage point faster than the GDP deflator. Thus, the factors model uses a relative medical price inflation assumption of 0.75 percent per year, which is consistent with research on productivity growth in medical care and long-term historical trends in the deflators for personal health care and GDP.[46]

Finally, it is assumed in the factors model that the out-of-pocket share of national health expenditures remains unchanged over the projection period. This assumption reflects, in part, that the average cost sharing associated with the Medicare benefit is likely to remain stable over the long-range projection period under current law, including consideration of the effects of supplemental coverage through private Medigap policies, Medicare Advantage plans, employer-sponsored retiree health plans, and Medicaid.

Results

The factors model output was used to determine the year-by-year growth rates for overall national health spending and volume and intensity in the 2022 Trustees Report. Figure A.5. below shows the excess cost growth rates from the factors model based on the methods and assumptions described above. As noted in the main body of this memorandum, the volume and intensity growth rates from the factors model were used with the Medicare-specific payment rate updates under current law and anticipated impacts on volume and intensity to obtain the projected increases in Medicare expenditures per beneficiary by type of service.

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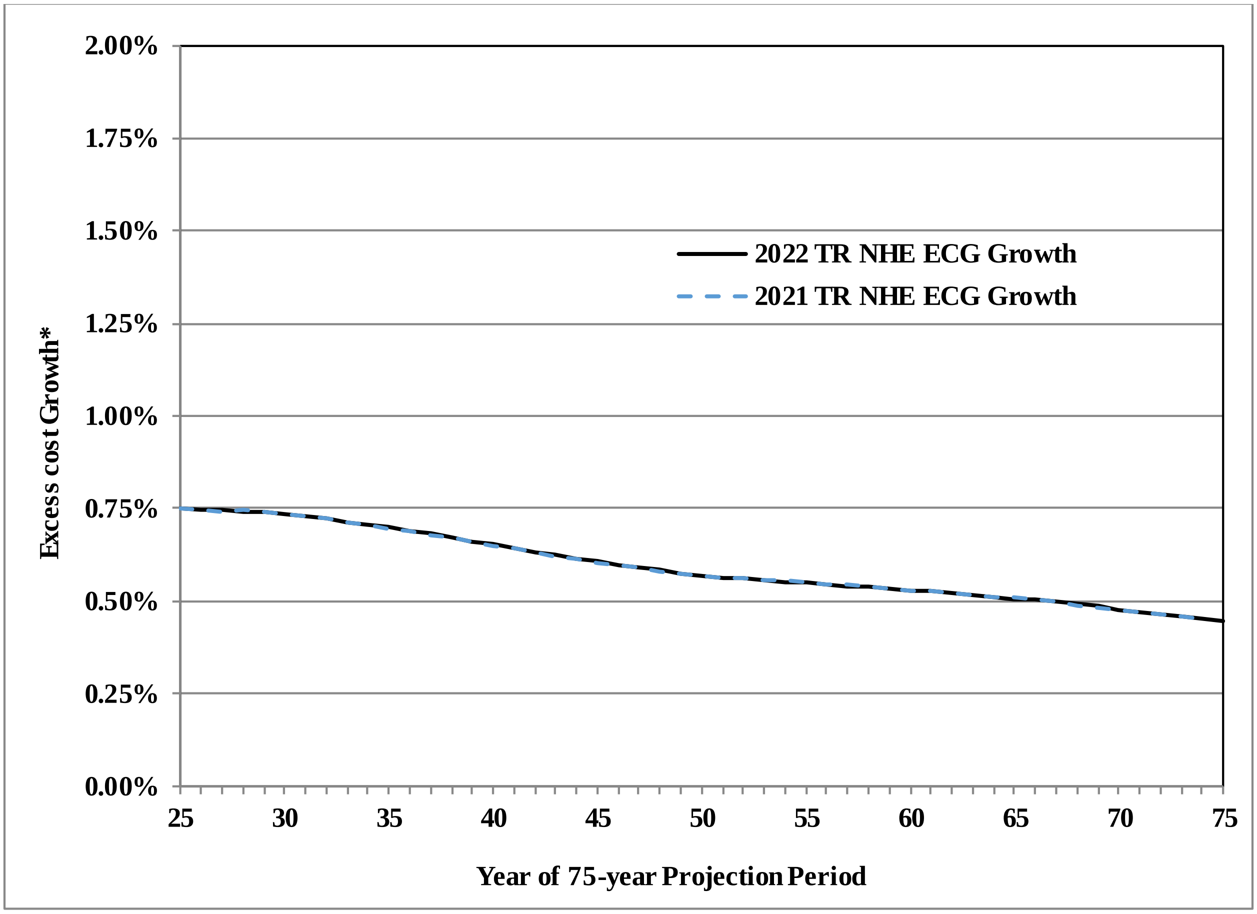
[45] Information on updated estimates of hospital productivity is available at https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/ReportsTrustFunds/Downloads/ProductivityMemo2016.pdf Estimates of physician productivity are available here: Fisher, Charles. "Multifactor productivity in physicians' offices: An exploratory analysis." *Health Care Financing Review*, 29, no. 2 (2008): 15–32.

[46] CMS, Office of the Actuary, *National Health Expenditure Accounts:* http://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/NationalHealthAccountsHistorical.html

**Figure A.5.—Long-Range NHE Excess Cost Growth*
based on the Factors Model**



Source: Centers for Medicare & Medicaid Services, Office of the Actuary

NOTE: Excess cost growth is defined as growth in per capita health spending adjusted for demographics less growth per capita GDP.