INTERNAL REVIEW DRAFT: DO NOT QUOTE

Technical Paper Series
Congressional Budget Office
Washington, DC

INCORPORATING LONGEVITY EFFECTS INTO LONG-TERM MEDICARE PROJECTIONS

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Congressional Budget Office
Washington, DC

JANUARY 2004
2004-2

Technical papers in this series are preliminary and are circulated to stimulate discussion and critical comment. These papers are not subject to CBO's formal review and editing processes. The analysis and conclusions expressed in them are those of the authors and should not be interpreted as those of the Congressional Budget Office. The authors are grateful to John Sturrock and Todd Anderson for assistance in preparing the longitudinal Medicare data sets. References in publications should be cleared with the authors. Papers in this series can be obtained at http://www.cbo.gov (select Publications and then Technical Papers).

Abstract

The cost of the Medicare program will increase dramatically as the baby boom generation reaches retirement. Results from the Congressional Budget Office Long-Term Model (CBOLT) indicate that Medicare costs will equal more than 9 percent of GDP by 2078. This paper considers the impact of replacing the Centers for Medicare and Medicaid Services approach of using an age- and sex-based model with one that is also based on age and sex but adds time until death to the forecasting model. Other researchers have found that using only age and sex can significantly overstate future Medicare costs. Incorporating a model that uses age, sex, and time until death into CBOLT does not alter the conclusion that the cost of the Medicare program is going to increase significantly, but by holding projected excess cost growth constant, it does lower predicted costs by more than 5 percent by 2078.

1. Introduction

Over the next few decades, the cost of the Medicare program will increase dramatically as the baby boom generation reaches retirement. Total Medicare expenditures accounted for 2.6 percent of GDP in 2002, and the Centers for Medicare and Medicaid Services (CMS) estimates that by 2035 Medicare spending will account for 5.3 percent of GDP, increasing to 9.3 percent by 2076 (Board of Trustees, 2003). This paper explores an alternative to CMS's basic methodology to project future Medicare costs: including time until death in the forecasting model. The new methodology does lower long-run Medicare forecasts, but it does not fundamentally change the prediction that Medicare costs will become an increasing economic burden, assuming that current law persists.

When projecting future Medicare costs, CMS uses trends in Medicare spending to forecast expenditures conditional on health status in the short term. Of note here is that CMS proxies health status by age and sex (Cutler and Sheiner, 1998). This assumption implies that medical needs change only as the age and sex distribution of the population changes. It does not take into account the idea that, as life expectancy improves, years of good health may also improve. That is, there is no allowance for the possibility that, as longevity improves, the costs associated with the end of life may be delayed until older ages.

In the long run, CMS assumes that growth in costs per beneficiary is equal to the growth in GDP per capita plus 1 percentage point. Note that this 1 percent excludes the impact of demographic change in the population, which is estimated separately (Board of Trustees, 2003).

The alternative approach to forecasting Medicare costs introduced in this paper adds an additional dimension to the proxy for health status: time until death. Although longevity increases need not be associated with improved morbidity, recent research does find such a correlation, at least with regard to the elderly (Lubitz, Cai, et al., 2003). The relationship between age and Medicare costs can be explained largely by time until death (see for example, Miller, 2001, and Stearns and Norton, 2002). In contrast to a model that forecasts population only by age and sex, a model that also includes time until death allows for the high costs associated with the final year of life to be delayed to more advanced ages as life expectancy increases. This is what Miller (2001) refers to as the delay-of-morbidity hypothesis. Excluding time until death can overstate forecasts of lifetime Medicare costs by as much as 16 percent by some estimates (Stearns and Norton, 2002).

In addition to adding time until death into the forecasting model, this paper also investigates the impact of forecasting not only aggregate Medicare costs but also category specific costs (inpatient hospital; skilled nursing facilities or SNF; hospice; home health; outpatient hospital; physician and other Part B utilization; and managed care) in the context of a larger policy-simulation model. This allows for a more flexible policy-analysis tool. Further, most research on this issue has focused solely on forecasting aggregate costs in a stand-alone model rather than on incorporating Medicare forecasts into a broader model.

A key factor underlying this analysis is the cost index itself. When looking at cost indices by age and sex costs increase with age, not surprisingly, for both men and women until about age 90 and then drop off slightly. In a regression framework, age and sex actually explain very little of the variation in Medicare costs. When time until death is added to that framework, the explanatory power of the covariates increases more than tenfold. Not surprisingly, costs for individuals in the last year of life are higher than for individuals further from death at all ages. Costs for both men and women in the last year of life decline somewhat with age, while costs for those surviving more than one year are relatively flat.

These cost indices are then incorporated into the Congressional Budget Office Long-Term Model (CBOLT). The model uses the assumption adopted by CMS and in prior CBO analyses that costs per beneficiary will grow with GDP per capita plus 1 percentage point in the long run. This 1 percentage point will be referred to as "excess cost growth" (all cost growth not explained by changing demographics or by growth in GDP per capita). The cost indices are fixed and do not vary over time.

Forecasting Medicare costs by using a model that includes time until death does not change the conclusion that the cost of the Medicare program will increase significantly, nor does it change the time frame by which it happens. Forecasts of total Medicare costs as a percentage of GDP are the same as the CMS estimate for 2035 and are only slightly lower for 2076. Comparing forecasts produced by CBOLT using an age and sex index and an age, sex, and time-until-death (TUD) index, by 2078 the forecast produced using the age-sex model is just over 5 percent higher than the forecast using the age-sex-TUD model. The results are similar when forecast in aggregate and by category.

2. Demographic Determinants of Medical Expenditures

With the impending retirement of the baby boomers, the potential impact of demographics on Medicare spending has received a great deal of attention from researchers. Underlying CMS Medicare forecasts is a fixed age-sex index. However, researchers have found that age and sex are poor indicators of health care costs. As an alternative, models have been developed that include time until death as well as age and sex. The general conclusion has been that excluding time until death leads to forecasts that overstate costs.

Cutler and Sheiner (1998) set out a framework for evaluating the impact of demographic change, noting that total medical spending depends on the number of people in a given age group, the health status of that age group, and average medical spending conditional on that health status. Each of these factors changes over time. That the population will become increasingly elderly is easy to predict. Forecasting the average health status of a population and the spending conditional on that health status is more complicated.

Previous analysis has shown that health care expenditures increase quite dramatically as death approaches, and empirical analysis performed for this paper supports that conclusion. Further, the literature shows that expenditures by time until death have been stable over time (see, for example, Lubitz and Riley, 1993). Using data from the Continuous Medicare History Sample, and restricting their sample to beneficiaries ages 65 or older and not enrolled in Medicare managed care, Lubitz and Riley find that the proportion of Medicare payments accounted for by decedents, defined as persons in their last year of life, fluctuated very little from 1976, when 28.2 percent of payments were for decedents through 1988, when 27.2 percent of payments were for decedents. Garber, MaCurdy, and McClellan (1998) find that, despite compositional changes in the expenditures of decedents, total expenditures accounted for by decedents were consistent from 1988 to 1995.

The literature also shows that Medicare costs are very strongly associated with time until death and are only weakly associated with age. Using the Continuous Medicare History Sample, a 5 percent sample of Medicare beneficiaries, Lubitz, Beebe, and Baker (1995) analyze data for all Medicare beneficiaries ages 65 and older who died in 1989 or 1990. They exclude from their analysis all beneficiaries enrolled in HMOs, beneficiaries with end stage renal disease (ESRD), and beneficiaries not continuously enrolled in both Hospital Insurance (HI) and Supplementary Medical Insurance (SMI). Classifying Medicare costs by both age and time until death, Lubitz et al. find that costs in the third through tenth years before death vary quite little by age. They do note a decline in the level of payments by age in the last two years of life; that is, at advanced ages, payments within the last two years of life decline with age.

Extrapolating from the Lubitz et al. analysis, Miller (2001) argues that age is a poor proxy for health status and cannot be used reliably as a basis for forecasts. He argues that time until death is a better measure of health status because, as life expectancy increases, time until death allows for the delay in high costs associated with the end of life. Using age alone (or age and sex) makes no such allowance and assumes that, as longevity increases, there is simply an increase in the number of high-cost years. Because end of life costs decline with age, Miller believes that a forecasting model that uses both age and time until death is likely to understate future costs and that the current relationship between age and time until death is not likely to persist into the future.

In using time until death as a proxy for health status, Miller assumes that the high health costs and the period of morbidity that accompany the end of life are delayed. This contrasts with the assumption inherent in an age-and-sex-based forecasting model, where increased longevity simply extends the period of higher costs and morbidity near the end of life. Miller assumes that Medicare expenditures can be decomposed into three multiplicative factors: the number of enrollees, the average cost per enrollee, and a general price-level factor.

The following notation is used throughout this paper:

X_t	Medicare benefits in year *t*
π	Medical inflation
N_{asdt}	Number of Medicare enrollees in year *t* by age (*a*), sex (*s*), and time until death (*d*)
χ_{asd}	Average Medicare costs by age (*a*), sex (*s*), and time until death (*d*) in base year

Specifically, when using an age model, Miller expresses aggregate benefits as the following:

$$X_t = e^{\pi t} * \sum_{a=65}^{120} \chi_a * N_t^a$$

Similarly, for projections using time until death, the model is as follows:

$$X_t = e^{\pi t} * \sum_d \chi_d * N_{dt}$$

Miller projects costs both by age and by time until death. He finds that, by 2070, cost projections using the age model are 14 percent higher than projections using the time-until-death model for beneficiaries over age 65. This assumes an increase in life expectancy to 80.9 years by

2070, and uses what Miller describes as the conservative longevity forecast by the Social Security Board of Trustees.

More recent research by Stearns and Norton (2002) supports this finding. Stearns and Norton treat the exclusion of time until death as an omitted-variables problem that biases the estimated impact of age upward. They estimate two models: a simple model excluding time until death and an expanded model that includes both time until death and interactions of age with time until death. Their simple model assumes that health care expenditures are a function of age, sex, and geographical indicators. If time until death is an omitted variable that is negatively correlated with both health care expenditures and age, the estimated coefficient on age is biased upward. Their solution is to add time until death to the equation, arguing that the benefits of including time until death outweigh the problem of its potential endogeneity. Using the Medicare Current Beneficiary Survey and a logit model, Stearns and Norton first estimate the probability of any expenditure conditional on the covariates, for both their simple and expanded models. They then use ordinary least squares to estimate health care expenditures conditional on some use.

Using a split sample validation approach, Stearns and Norton find that the overall goodness of fit is better when using the expanded model that includes dummy variables indicating whether the person is in the first, second, third, or fourth quarter before death and the interactions of each of these variables with age. Adding the time-until-death variables greatly increases the explanatory power of the expenditure-level regressions. They find that using the simple model results in estimated lifetime expenditures for people ages 66 to 70 that are 10 percent higher than a model that includes time until death when using current life tables, and that this increases to 16 percent when projected life tables for 2020 are used.

3. Alternative Indices for Forecasting Total Medicare Spending

The first step in this analysis is to build a set of indices by age, sex, and time until death. For this analysis, an index is created for total Medicare costs and for the following six categories[1]:

- Inpatient hospital,
- Skilled nursing facilities,
- Hospice,
- Home health,
- Outpatient hospital, and
- Physician and other provider service utilization.

These indices are used in forecasting costs and in constructing estimates of excess cost growth, both historically and over the ten-year budget window.

The indices are created using a longitudinal database that contains information on Medicare spending for covered services used by individual beneficiaries over several years. The database was produced by Acumen, LLC, and was derived from information recorded and maintained by CMS for Medicare claims processing.[2] The records include information on a 5 percent sample of beneficiaries enrolled in Medicare from 1989 through 1999. Beneficiaries are retained in the data set after death, and 5 percent of new enrollees are added each month. Data

[1] Cost information is not available for beneficiaries enrolled in managed care.

[2] Note that all major outliers (beneficiaries with more than $1 million in annual spending) have been removed from the data set.

include enrollment and entitlement status (aged fee-for-service, disabled fee-for-service, aged managed care, disabled managed care, not enrolled, or dead) for each month, dates of birth and death, race, sex, and zip code. Monthly utilization and expenditures are also included for the following categories: inpatient hospital, skilled nursing facility, hospice, home health, outpatient, and physician and other provider service utilization. Only Medicare covered spending is included here. Note that expenditures for durable medical equipment, a covered benefit, are not available in the data set.

Unlike previous research, this analysis includes Medicare beneficiaries under the age of 65. For this analysis, only beneficiaries never enrolled in managed care are included. Expenditure information is not available for beneficiaries for the time in which they were enrolled in a managed care plan, so to maintain a consistent panel, all beneficiaries ever enrolled in Medicare managed-care plans are excluded. The monthly data are aggregated to annual totals relative to the date of death. If a beneficiary dies on June 1, his or her final year begins on June 2 of the year preceding death and ends on his or her date of death. Annual totals relative to the date of death are calculated for all beneficiaries. For beneficiaries who do not die within the sample time frame, a death date of December 31, 1999 is assumed.

Although data are available through the end of 1999, for this analysis, the data set is truncated at the end of 1997.[3] Of interest here is how Medicare expenditures vary not only by age and sex but also by time until death (TUD). Specifically, this analysis looks at expenditures in the last year of life (TUD group 1), expenditures in the second-to-last year of life (TUD group 2), and expenditures prior to the final two years of life (TUD group 3). In order to have

[3] Note that truncating the data earlier has no impact on the average cost structure.

observations for groups 2 and 3, it was necessary to truncate the data. Note that the cost indices are by age, sex, and time until death are calculated relative to a 65 year old man with more than two years of life remaining.

Expenditures are deflated to 1990 dollars using GDP per capita. By removing the impact of per capita GDP growth, the coefficient on the time trend should represent, in dollar terms excess cost growth.

Average costs by age, sex, and time until death are calculated by using fixed-effects regressions that include a simple time trend. Note that, in all cases where age is used, it enters linearly after age 65 and in five-year age groups for ages 20 through 64. Observations for those age 19 and younger are grouped together to avoid small sample problems. Similarly, after age 91, observations are grouped because of the decreasing number of observations at advanced ages. Note that for the time trend (t) 1990 is equal to 1.

The notation used (in addition to that described earlier) is as follows:

D_{asd}	Dummy variable by age (*a*), sex (*s*), and time until death (*d*)
t	Time trend with t at 1990 equal to 1
β	Coefficient on time trend
GDP_t	GDP per capita in year t
η_t	Excess cost growth rate in year t

The following set of regressions is run.

$$(1)\ x_{it} = \chi_{as} * D_{as} + \beta t + \varepsilon_{it}$$

$$(2)\ x_{it} = \chi_{d} * D_{d} + \beta t + \varepsilon_{it}$$

$$(3)\ x_{it} = \chi_{asd} * D_{asd} + \beta t + \varepsilon_{it}$$

This set of regression models is used to estimate average total costs and category-specific average costs for each category listed above (inpatient hospital, SNF, hospice, home health, outpatient hospital, and physician and other provider service utilization).

Accounting for the time trend allows for the average costs by age, sex, and time until death to be calculated accurately regardless of the time period. Its inclusion effectively removes the effect of changes over time. This is particularly important for certain categories of costs where there were sharp changes in rates of growth and subsequent reform of payment systems, for example, during the period of analysis 1989 through 1997. To test the sensitivity of the results to the period included in the analysis, the analysis was run using a shortened time period, and the average costs were not sensitive to the years included.

In each regression model, all coefficients are statistically significant, but there are large differences in how much of the variation in the dependent variable is explained by the independent variables (see Table 1). For model 1, the R-squared is 0.01, indicating that age and sex explain very little of the variation in Medicare expenditures. The R-squared for model 2 (time until death only) is 0.13, and for model 3 (age, sex, and time until death) it is even higher at 0.15. This is consistent with the results in Stearns and Norton (2002). Age and sex alone explain much less of the variation in annual Medicare expenditures than either time until death alone or age, sex, and time until death combined.

In the case of each index, annual Medicare costs increase over time with the smallest annual increase in the age and sex case and the largest in the time-until-death case (see Table 1 for summary statistics). Although the estimates of excess cost growth (the coefficient on the time trend divided by the mean of the dependent variable) over the period 1990 to 1997 are all very similar at about 3 percent, the estimate is largest for the TUD index and smallest for the age and sex index. Omitted from the table are the p-values on the F-test on the significance of the fixed effects (χ). In each case, the p-value is less than 0.0001. Clearly, the fixed effects are jointly highly significant in each case.

The results are further summarized in the figures. Figure 1 summarizes the results from Model 1 for men and women. Rather than showing average costs per beneficiary, costs have been converted to an index where average costs for a 65-year-old male are equal to 1. As the figure shows, average program costs increase with age. The rate of increase is about the same for men and women, but costs for women are below costs for men after age 65. Before age 65, costs for women are above costs for men. Note the distinct drop in the index at age 65, as healthy 65-year-old beneficiaries enroll in Medicare.

Figures 2 and 3 show the cost indices by time until death. Figure 2 shows the results for men, and Figure 3 shows the results for women. As the figures show, the patterns are similar for men and women. For those who survive more than two years (TUD=3), average program costs increase with age until declining slightly as beneficiaries surviving more than two years enter their nineties. For men who die within 13-24 months (TUD=2), costs are relatively constant across ages until beneficiaries reach their eighties. For women, there is a more pronounced decline with age for TUD group 2. Lastly, looking at those within one year of death (TUD=1), we see that average costs generally decline with age. These are consistent with the results reported in Lubitz, Beebe, and Baker (1995). The declining pattern is more striking for women than for men. As with the indices by age and sex, there is a drop at age 65, as healthy 65-year-olds become eligible for Medicare.

Looking at cost indices that vary only by time until death, costs are highest for those who die within one year, at more than eight times higher on average than for an individual more than two years from death over the sample period 1990 through 1997. Costs for those who die within 13 to 24 months are three times higher than for those living longer than two years. (Note that these results are not shown graphically.) Again, this is consistent with previous research (see, for example, Miller, 2001).

The results are similar when looking at category-specific excess cost growth rates. Looking at each category of cost, again the models that include age, sex, and TUD fixed effects explain substantially more of the variation in expenditures than when only age and sex fixed effects are included (see Table 2). The p-values on the F-tests for the significance of χ are omitted from the table. In every case, the p-value is less than 0.0001, showing that, jointly, the χs are highly significant.

The coefficient on the time trend varies considerably across expenditure categories, in 1990 dollars. Looking at this coefficient relative to the mean expenditures for a given category provides an approximation of excess cost growth. Recall that growth in GDP per capita has already been removed from expenditures. These excess cost growth rates range from about 1 percent (the level CMS assumes long-run excess cost growth will be) to almost 20 percent. Estimated in this way, SNFs have the highest excess cost growth rate at almost 20 percent, followed by hospice at almost 18 percent, and home health at 16 percent. Excess cost growth for physicians and other Part B services has been close to 6 percent, and inpatient hospital close to 1 percent. Following this methodology, excess cost growth estimates for hospital outpatient are negative over this period. Note that these are not the excess cost growth rates used in the forecasting model. These are the excess cost growth rates for 1990 to 1997; the excess cost growth rates used in the forecasting model are calculated using the cost indices calculated here and the cost forecasts for 2003 through 2013.

Note that information on managed-care costs is not available from the panel data set; the index for total Medicare costs is used as an approximation for managed care. The age-sex profile for beneficiaries enrolling in managed care is almost indistinguishable from those not enrolling, and so there it seems reasonable to assume that costs relative to those for a 65-year-old male will be similar for both managed-care and fee-for-service beneficiaries.

4. Generating Long-Run Medicare Forecasts

Generating the long-run Medicare forecast required building a model that was fully integrated into the Congressional Budget Office Long-Term Model to take advantage of the detailed demographics and economic modules already contained within CBOLT.[4] A detailed set of Medicare calculations that incorporate these new cost indices have been added to CBOLT. These calculations include forecasting the number of Medicare beneficiaries both aged and disabled. Previous research in this area focused only on elderly Medicare beneficiaries. Medicare costs are assumed to grow with the change in beneficiaries (N_{asd}) multiplied by the cost index (χ_{asd}) , GDP per capita, and excess cost growth(η_t). Specifically,

[4] For an introduction to the CBOLT model, see Congressional Budget Office (2001).

$$X_t = X_{t-1} * \frac{\sum_{a=1}^{100}\sum_{s=1}^{2}\sum_{d=1}^{3} N_{asdt} * \chi_{asd}}{\sum_{a=1}^{100}\sum_{s=1}^{2}\sum_{d=1}^{3} N_{asd(t-1)} * \chi_{asd}} * \frac{GDP_t}{GDP_{t-1}} * (1+\eta_t)$$

As stated earlier, excess cost growth accounts for all growth in benefits not accounted for by demographic change and economic growth.

Developing estimates of the beneficiary population by age, sex, and time until death involves estimating total population by time until death, developing a set of ratios of beneficiaries to total population, and then applying those ratios to population projections. CBOLT uses a detailed demographics module to forecast population by age and sex , and that population is distributed across the three time-until-death (TUD) categories. Calculating the percentage of people expected to die within 12 months (TUD category 1), 13 to 24 months (TUD category 2), and 25 or more months (TUD category 3) involves applying age and sex specific cohort survival probabilities to the underlying population. In particular, the number of people expected to die with the next 12 months is calculated as the population times one minus the probability of surviving an additional year. For TUD group 2, the process is repeated for one minus the probability of surviving an additional two years, then subtracting the number expected to die within one year. The number of people in TUD category 3 is the residual after subtracting the other two categories from the population for that age and sex. This process is repeated for disabled worker beneficiaries to calculate the number of beneficiaries in each time-until-death category.

The next step is to calculate the number of beneficiaries for each year. Starting with beneficiaries by age and sex group for 2002 (data provided by CMS), the ratio of beneficiaries to population is calculated for each age and sex group for the population, ages 1 through 100. For those ages 21 to 64, the process is different. The number of disabled worker beneficiaries (on Social Security Disability Insurance for two or more years) is subtracted from the number of Medicare beneficiaries, and any remaining beneficiaries are calculated as a percentage of the population for each age, sex, and time-until-death group. Note that this remainder is a small group and represents beneficiaries with end stage renal disease.[5]

The calculated ratios are then applied to population (or to population by time until death) to solve for the number of Medicare beneficiaries. In the case of population by time until death, the same percentage of each TUD group for each age and sex group are assumed to be beneficiaries. That is, if 95 percent of 66-year-olds are beneficiaries, 95 percent of those assumed to die with one year, two years, and beyond are assumed to be beneficiaries. Beneficiaries as a percentage of the population are then scaled to match official CBO estimates of the number of beneficiaries until the end of the ten-year budget window. These scaled percentages are used to forecast beneficiaries after the end of the ten-year budget forecast period.

To calculate the number of beneficiaries enrolled in managed care, the Medicare panel data set (described above) is used. Specifically, the data are used to calculate the percentage of beneficiaries, by age and sex, who were enrolled in managed care in 1999, the last year for which those data are available. Those percentages are applied to the calculated number of Medicare

[5] The model is being refined to include a separate set of cost indices for ESRD beneficiaries and to more accurately identify such beneficiaries.

beneficiaries, to arrive at an estimate of Medicare managed-care enrollment. Note that no beneficiaries under the age of 20 are allowed to be enrolled in managed care.[6]

Excess cost growth is calculated separately for each category of spending and each index (age-sex, age-sex-TUD, and TUD). Recall that excess cost growth refers to all growth that is not accounted for by changes in demographics of growth in per capita GDP. In projection years 1 through 10, excess cost growth is calculated as a residual. Specifically, it is calculated such that CBOLT projected costs match official CBO projections for each category of spending. For year 11, excess cost growth is equal to the average of the previous ten years. In years 12 through 25, excess cost growth rates gradually approach the long-run excess cost growth rate of 1 percent. After year 25, excess cost growth is simply equal to the long-run rate. That is, all categories go to 1 percent excess cost growth. This is consistent with CMS assumptions (Board of Trustees, 2003). The same long-run excess cost growth rates are used for each index.

5. Implications for Excess Cost Growth and Long-Run Forecasts

The choice of cost index will have consequences for estimates of excess cost growth, both historical estimates and those into the forecast period, and for Medicare cost forecasts. As Figure 4 shows, historically there has been a large amount of variation in excess cost growth regardless of index used. The two excess cost growth series track each other very closely.[7]

[6] The only way an individual under the age of 20 can be eligible to become a Medicare beneficiary is because of end stage renal disease, and ESRD beneficiaries are not allowed to enroll in Medicare managed care. (Beneficiaries enrolled in managed care who later develop ESRD are permitted to continue their enrollment.)

[7] The results are similar when using only a time-until-death only index, but for clarity of exposition, that line has been omitted from the chart.

Historical excess cost growth is calculated in the same way as excess cost growth over the ten-year budget window: growth in the cost index multiplied by the beneficiary population and growth in GDP per capita are removed from growth in benefits. Because a historical series of beneficiary counts by age and sex was not readily available, beneficiaries were calculated using the 2002 ratio of beneficiaries to population. As a result, some of the fluctuation in excess cost growth is actually attributable to programmatic changes that increased the number of eligible beneficiaries. The large excess cost growth rates for 1974 and 1975, for example, are attributable to the addition of disabled worker and ESRD beneficiaries to the Medicare roles. The low excess cost growth rates of the late 1990s are the result of the cost-containment measures in the Balanced Budget Act of 1997. Although there has clearly been a lot of variability in excess cost growth, it does appear that the degree of variability has been declining over time.

Average excess cost growth declines as the period considered begins later. Using the age-sex-TUD model, the average from 1970 through 2002 is 2.9 percent.[8] This decreases to 2.7 percent from 1980 to 2002 and to 2.0 percent from 1990 to 2002. Indeed, for 1998 to 2002 the average excess cost growth rate is -0.6 percent. In each of these time periods, there is considerable variation in excess cost growth rates. In the forecast for 2004 to 2013, excess cost growth is relatively stable and averages around 1 percent (the assumed long run excess cost growth rate).

Over the ten-year budget window there is a lot of variation in inferred excess cost growth between categories (see Table 3). Interestingly, there is not a consistent relationship between the magnitude of excess cost growth and the choice of model. In most cases, excess cost growth is

[8] These are arithmetic means.

largest when the age-sex-TUD model is used. Using the age-sex-TUD model, average excess cost growth rates vary over the period 2003 to 2013 from a high of 5.2 percent for home health to a low of -0.6 percent for skilled nursing facilities. The range when using the age-sex model is -0.7 percent for skilled nursing facilities to 4.9 percent for home health.

These differences, although generally small, can affect long-run forecasts because not only are the excess cost growth rates different, but so are the cost indices. As Figure 5 shows, using the age-sex cost model results in the highest forecast of Medicare costs as a percentage of GDP, and the time-until-death model results in the lowest forecast. The cost forecast using the age, sex, and time-until-death model falls between the forecasts that use an age-and-sex index and a time-until-death index separately. Interestingly, Miller (2001) believes that a model including both age and time until death will understate future costs. Results here, however, show that the model using only time until death produces lower cost forecasts than the model using age, sex, and time until death.

Figures 6 through 12 show the category specific and Medicare managed-care forecasts as a percentage of GDP. Note that through 2013 all forecasts are identical and match official CBO forecasts (on a calendar-year basis). The cost index that produces the highest forecast varies by category. For inpatient hospital (Figure 6), the age-sex index produces the highest forecast, reaching 3.5 percent of GDP by 2078 (up from 1 percent in 2003); using an age-sex-TUD index results in a slightly lower forecast, at 3.2 percent of GDP by 2078.

As figure 8 shows, there is some variation in the forecast for SNF costs. Here using a TUD index results in the lowest forecast and an age-sex index the highest. Using a TUD index, SNFs are projected to rise to 0.40 percent of GDP by 2078 (from 0.13 percent in 2003); using an age-sex index increases that forecast to 0.49 percent. For home health costs (Figure 9), using a TUD index results in the lowest forecast, at 0.83 percent of GDP by 2078; using an age-sex-TUD index results in the highest cost forecast at, 0.93 percent of GDP. For hospice (Figure 7), an age-sex index results in the highest cost. Using the age-sex index, hospice costs are predicted to reach 0.25 percent of GDP by 2078; using an age-sex-TUD or a TUD index, that forecast falls slightly, to 0.22 percent.

Looking at outpatient hospital (Figure 10), costs are highest using an age-sex index and lowest using a TUD index. Specifically, using the age-sex index, costs reach 0.83 percent of GDP by 2078 (up from 0.12 percent in 2003), and using a TUD index, costs reach 0.78 percent of GDP. Physician and other Part B costs (Figure 11) follow a different pattern. Using a TUD index, costs are forecast to reach 2.8 percent of GDP by 2078 (up from 0.78 percent of GDP in 2003). An age-sex-TUD index results in the lowest forecast, at 2.73 percent of GDP. Managed-care costs (Figure 12) are predicted to be highest when using an age-sex index, reaching 0.99 percent of GDP by 2078. A TUD index results in the lowest forecast, at 0.90 percent of GDP. The category-specific results are summarized in Figure 13.

Finally, looking back at total costs (where "total" is defined as the sum of the parts, not a separately forecast total), overall the age-sex forecast is the highest and the age-sex-TUD forecast is the lowest (Figure 5). Total costs are predicted to reach 9.27 percent of GDP by 2078 using an age-sex-TUD index and 9.75 percent using an age-sex index.

Other researchers have found a difference of 14 percent in 2070 between an age and a time-until-death model (Miller, 2001) and a difference of 16 percent in lifetime expenditures between a simple model using age and sex and an expanded model that adds time until death for

66- to 70- year-olds (Stearns and Norton, 2002). The differences found here are smaller and likely result from the fact that the model used here forecasts Medicare costs for all Medicare beneficiaries rather than just for elderly beneficiaries or a subset thereof.

Holding excess cost growth constant, by 2078 total medicare costs as a percentage of GDP, projected using an age-sex model, are just over 5 percent higher than those projected using an age-sex-TUD model. The differences between the highest and the lowest cost forecasts (in terms of percentage of GDP) range from 14 percent for hospice to just over 1 percent for home health costs in 2078. So, although the choice of model does affect cost forecasts over the long term, the differences in the forecasts do not alter the conclusion that the financial burden on the Medicare system will increase significantly.

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Table 1
Summary Statistics

Model	R-squared	Estimated β (standard errors)	Mean of Dependent Variable	β/Mean of Dependent Variable
(3) Age-Sex-TUD	0.15	118.0	3,526.5	0.033
		(1.1)		
(1) Age-Sex	0.01	111.1	3,526.5	0.031
		(1.1)		
(2) TUD	0.13	121.3	3,526.5	0.034
		(1.1)		

Table 2
Summary Statistics, Category-Specific Indices

Model	R-squared	Estimated β (standard errors)	Mean of Dependent Variable	β/Mean of Dependent Variable
Inpatient Hospital				
Age-Sex-TUD	0.12	22.0 (0.8)	1,818.7	0.012
Age-Sex	0.01	17.6 (0.8)	1,818.7	0.009
TUD	0.11	23.2 (0.8)	1,818.7	0.013
SNF				
Age-Sex-TUD	0.05	26.5 (0.1)	136.9	0.194
Age-Sex	0.02	26.4 (0.1)	136.9	0.193
TUD	0.04	26.8 (0.1)	136.9	0.196
Hospice				
Age-Sex-TUD	0.03	5.2 (0.1)	29.0	0.180
Age-Sex	0.00	5.1 (0.1)	29.0	0.175
TUD	0.02	5.2 (0.1)	29.0	0.178
Home Health				
Age-Sex-TUD	0.03	64.5 (0.3)	396.2	0.163
Age-Sex	0.01	63.9 (0.3)	396.2	0.161
TUD	0.02	65.0 (0.3)	396.2	0.164
Outpatient Hospital				
Age-Sex-TUD	0.11	-2.6 (0.2)	928.5	-0.003
Age-Sex	0.01	-3.9 (0.2)	928.5	-0.004
TUD	0.09	-2.8 (0.2)	928.5	-0.003
Physicians/Other Part B				
Age-Sex-TUD	0.03	19.5 (0.2)	335.6	0.058
Age-Sex	0.01	18.8 (0.2)	335.6	0.056
TUD	0.02	21.1 (0.2)	335.6	0.063

Table 3
Inferred Excess Cost Growth Detail by Category
Percent Change, 2003-2013

	Medicare Benefits	Cost Index times Population	GDP per Capita	Derived Excess Cost Growth
Age-Sex-TUD				
Hospital Inpatient	6.3%	2.2%	4.1%	0.0%
Skilled Nursing Facilities	5.6	2.5	4.1	-0.6
Home Health	11.8	2.4	4.1	5.2
Hospice	9.0	2.6	4.1	2.7
Hospital Outpatient	10.9	2.4	4.1	4.2
Physicians/Other Part B	7.5	1.7	4.1	0.8
Group Plans	3.4	-2.9	4.1	2.4
Total	6.8	1.7	4.1	1.0
Age-Sex				
Hospital Inpatient	6.3%	2.3%	4.1%	-0.2%
Skilled Nursing Facilities	5.6	2.5	4.1	-0.7
Home Health	11.8	2.6	4.1	4.9
Hospice	9.0	2.3	4.1	2.3
Hospital Outpatient	10.9	2.5	4.1	4.1
Physicians/Other Part B	7.5	1.7	4.1	0.7
Group Plans	3.4	-2.8	4.1	2.3
Total	6.8	1.7	4.1	0.8
TUD				
Hospital Inpatient	6.3%	2.5%	4.1%	-0.1%
Skilled Nursing Facilities	5.6	2.6	4.1	-0.8
Home Health	11.8	2.5	4.1	5.0
Hospice	9.0	2.5	4.1	2.7
Hospital Outpatient	10.9	2.5	4.1	4.1
Physicians/Other B	7.5	2.5	4.1	0.9
Group Plans	3.4	-2.7	4.1	2.3
Total	6.8	1.9	4.1	0.9

Figure 1
Aggregate Age-Sex Indices

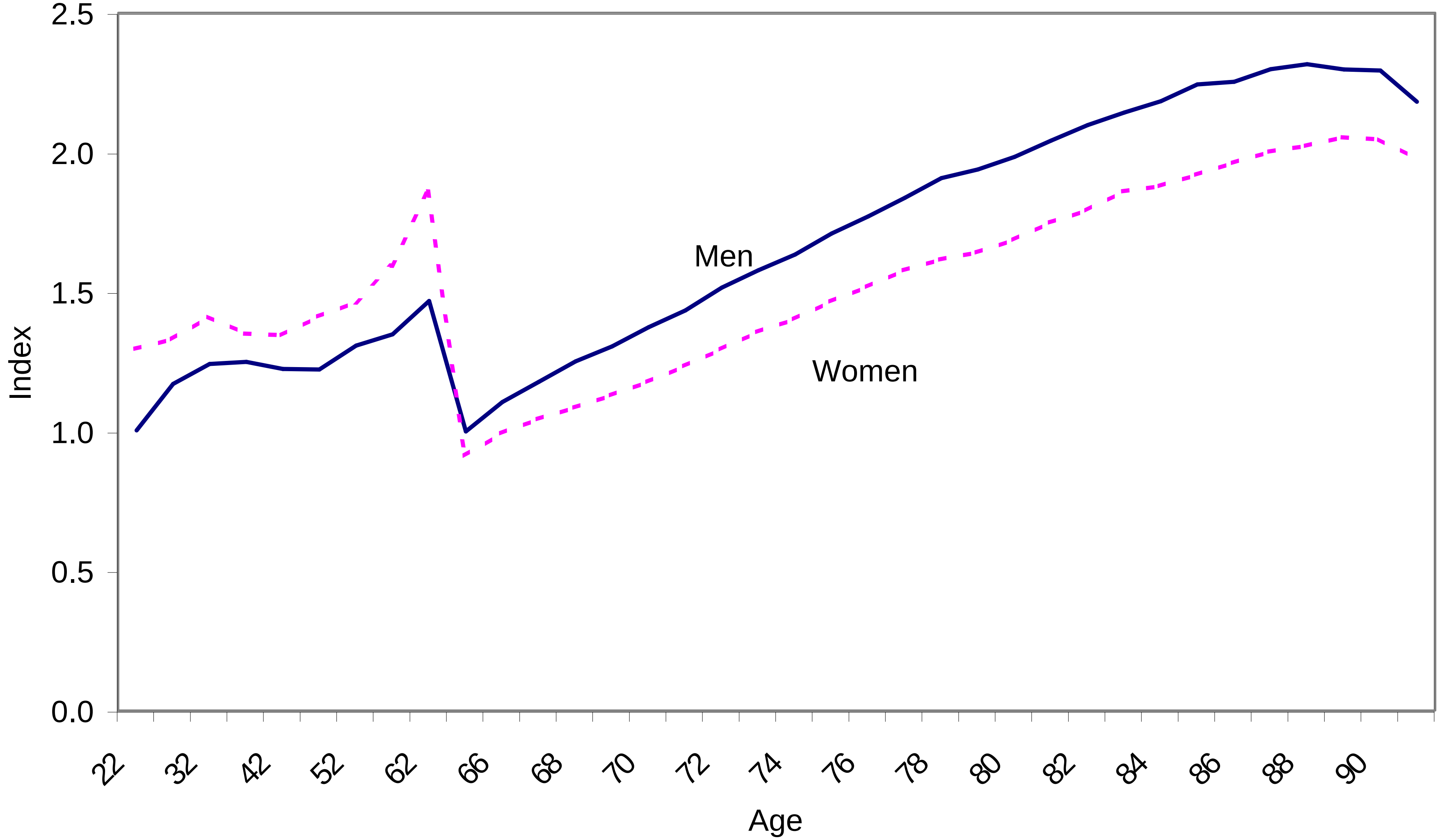

Figure 2
Aggregate Costs Indices by Time Until Death, Men

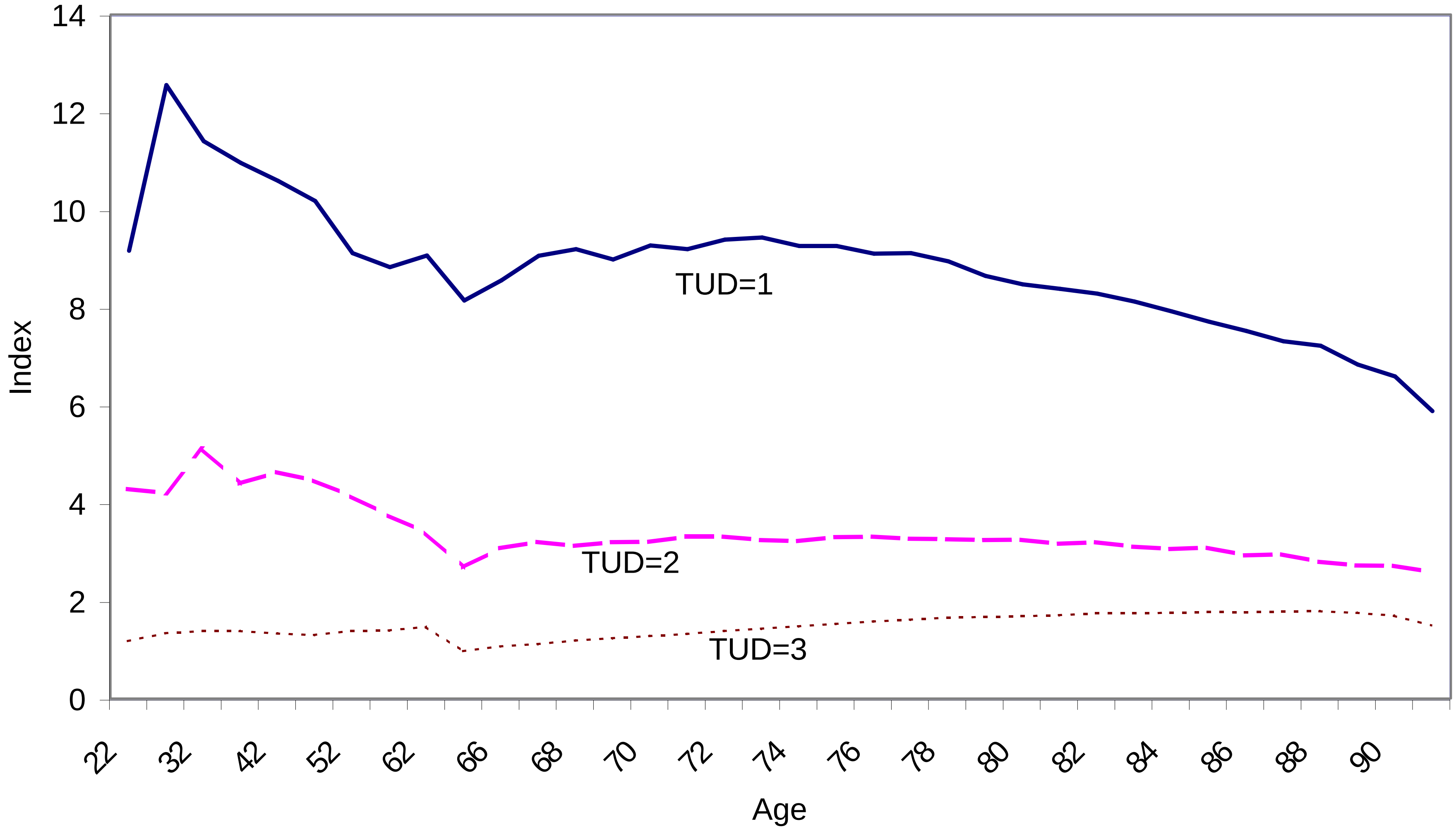

Figure 3

Aggregate Costs Indices by Time Until Death, Women

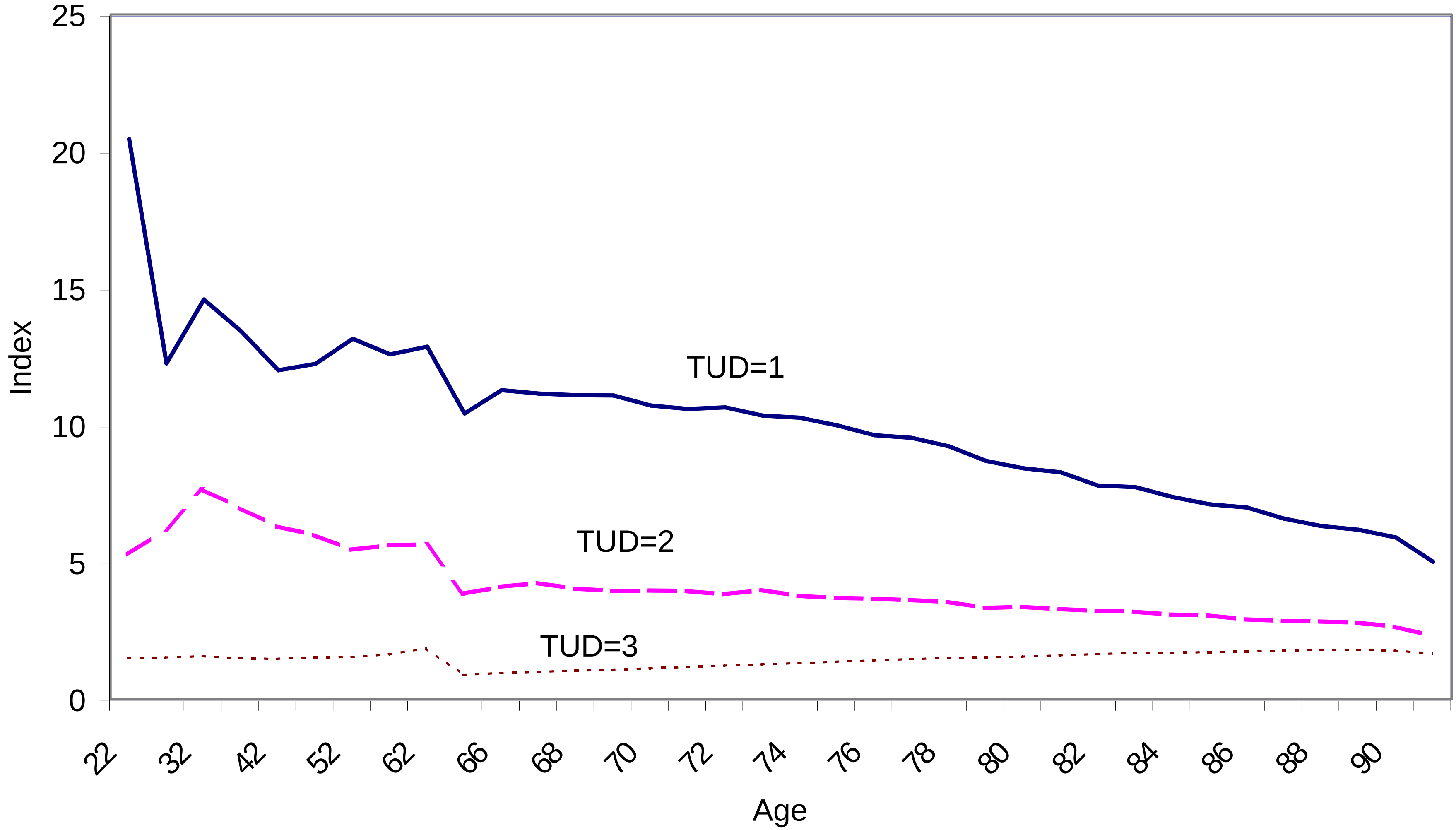

Figure 4
Excess Cost Growth Using an Age-Sex vs. an Age-Sex-TUD Index

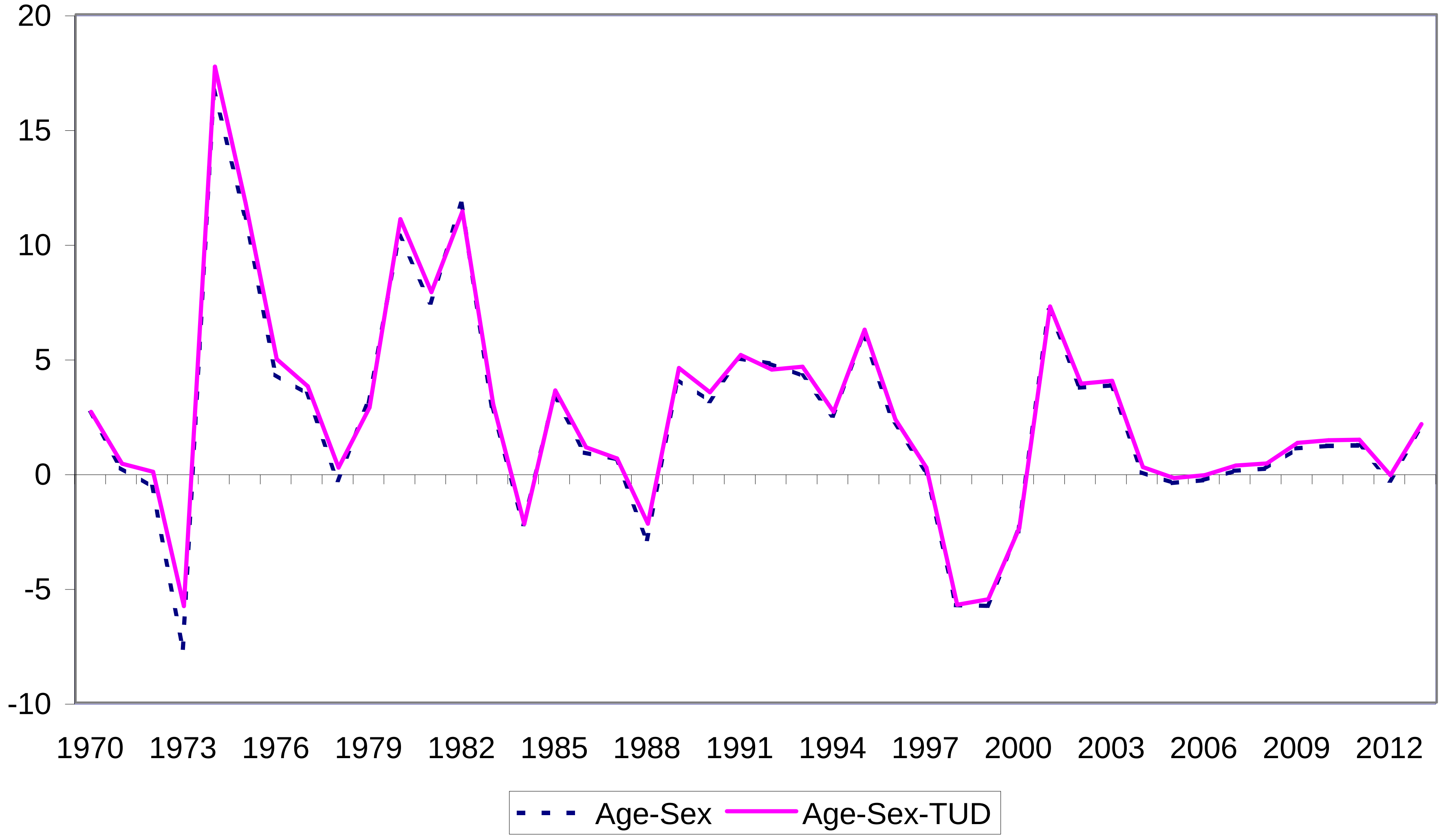

Figure 5
Total Medicare Costs as a Percentage of GDP

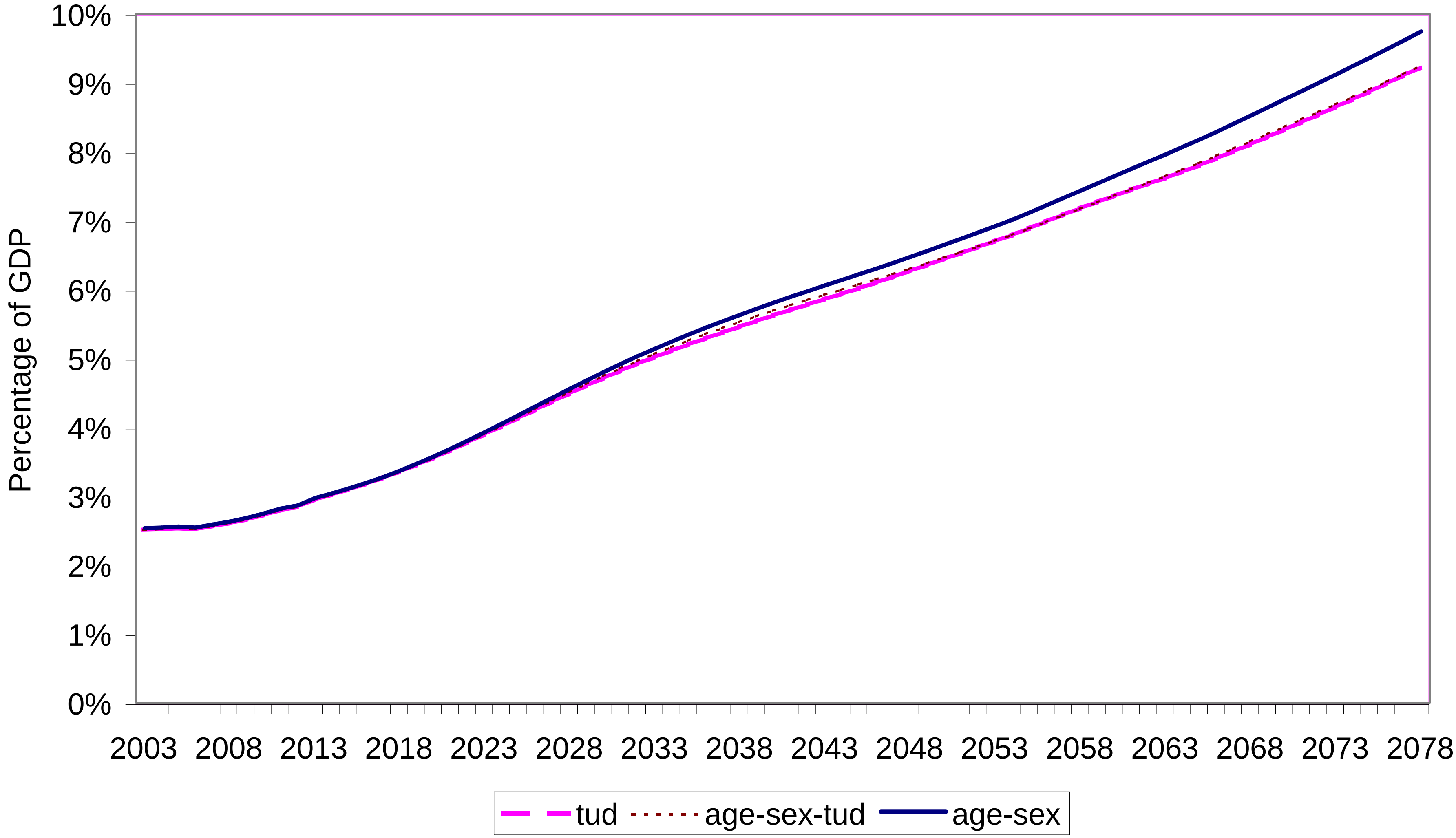

Figure 6
Inpatient Hospital Costs as a Percentage of GDP

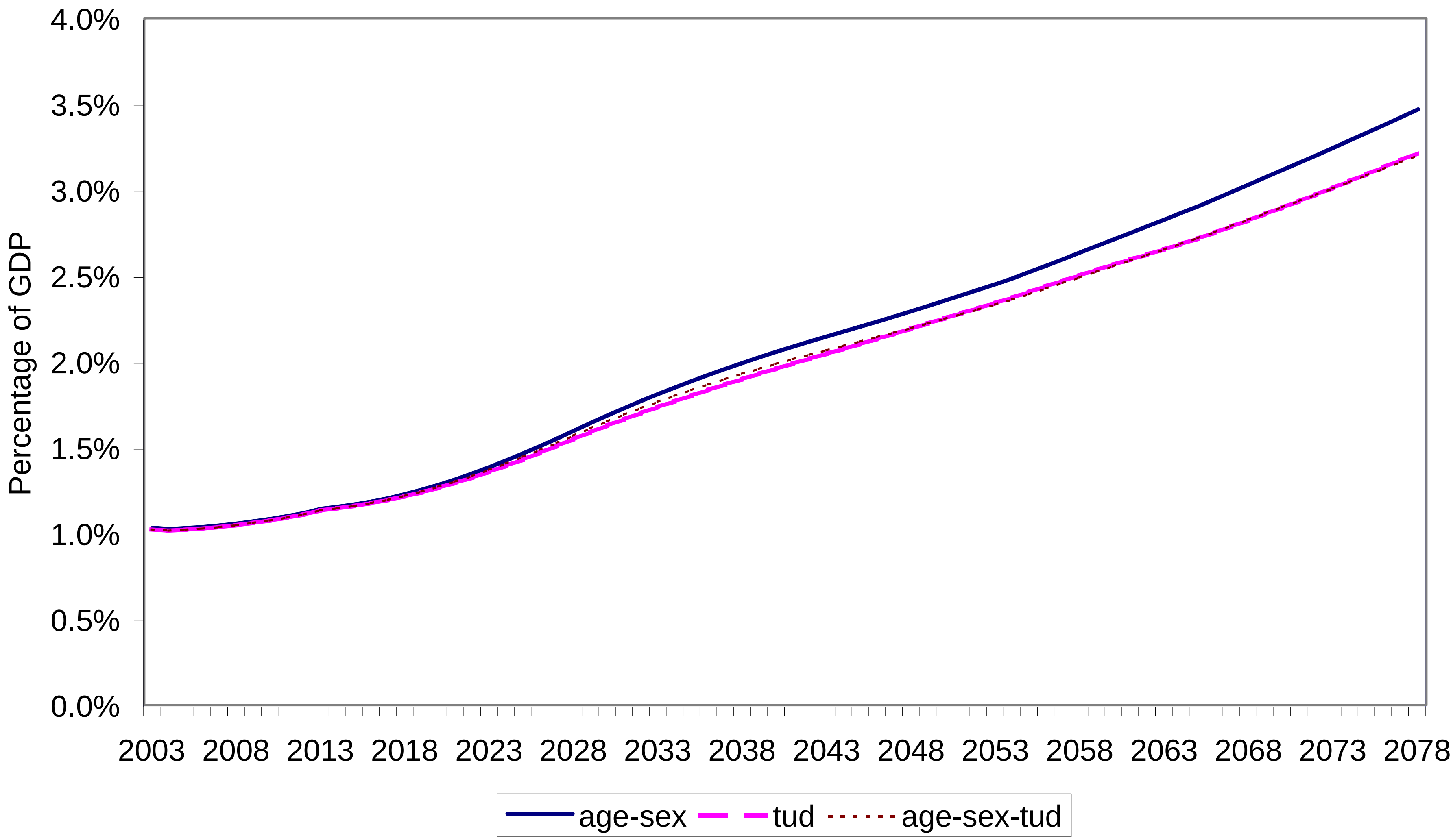

Figure 7
Hospice Costs as a Percentage of GDP

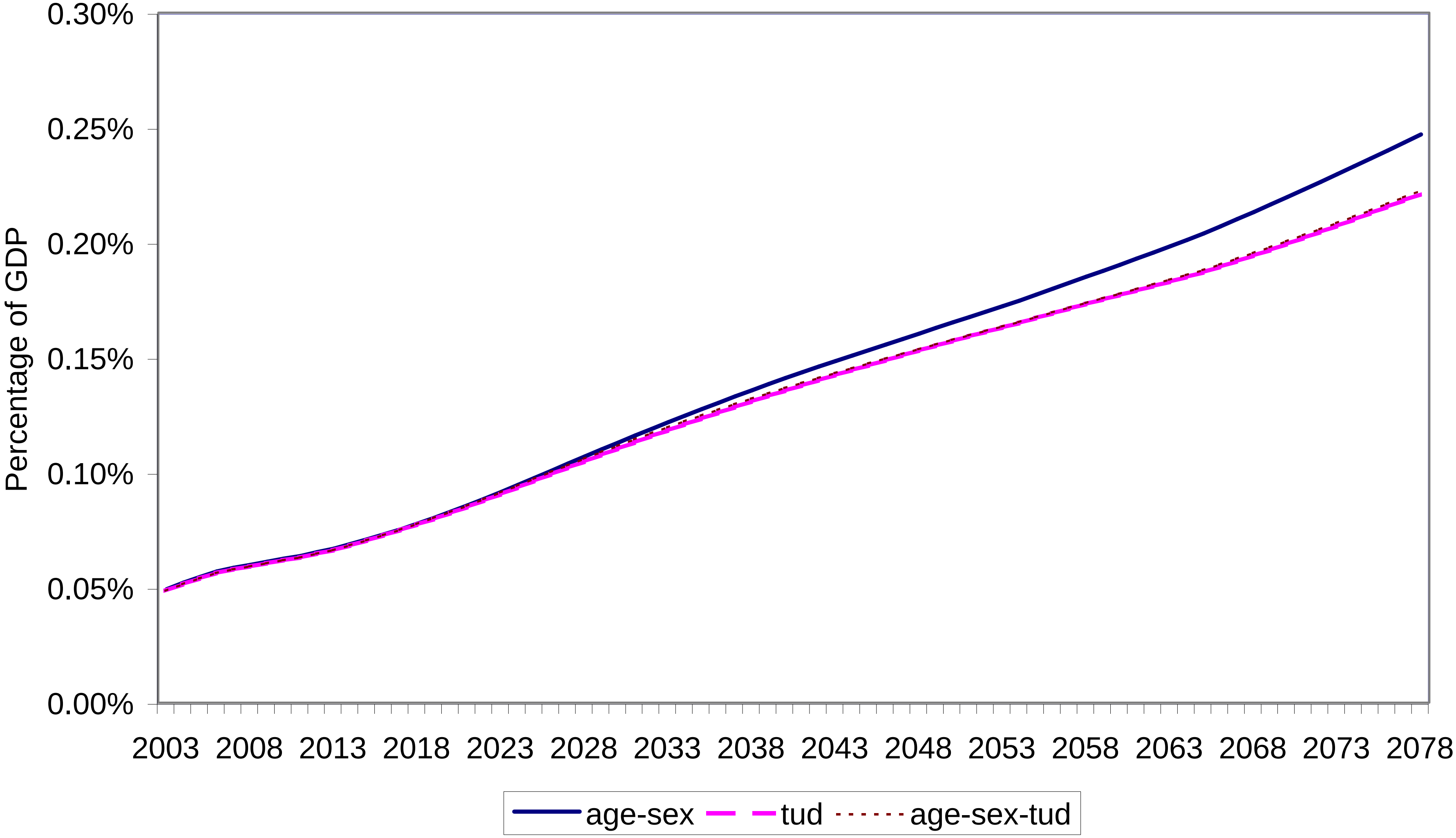

Figure 8
SNF Costs as a Percentage of GDP

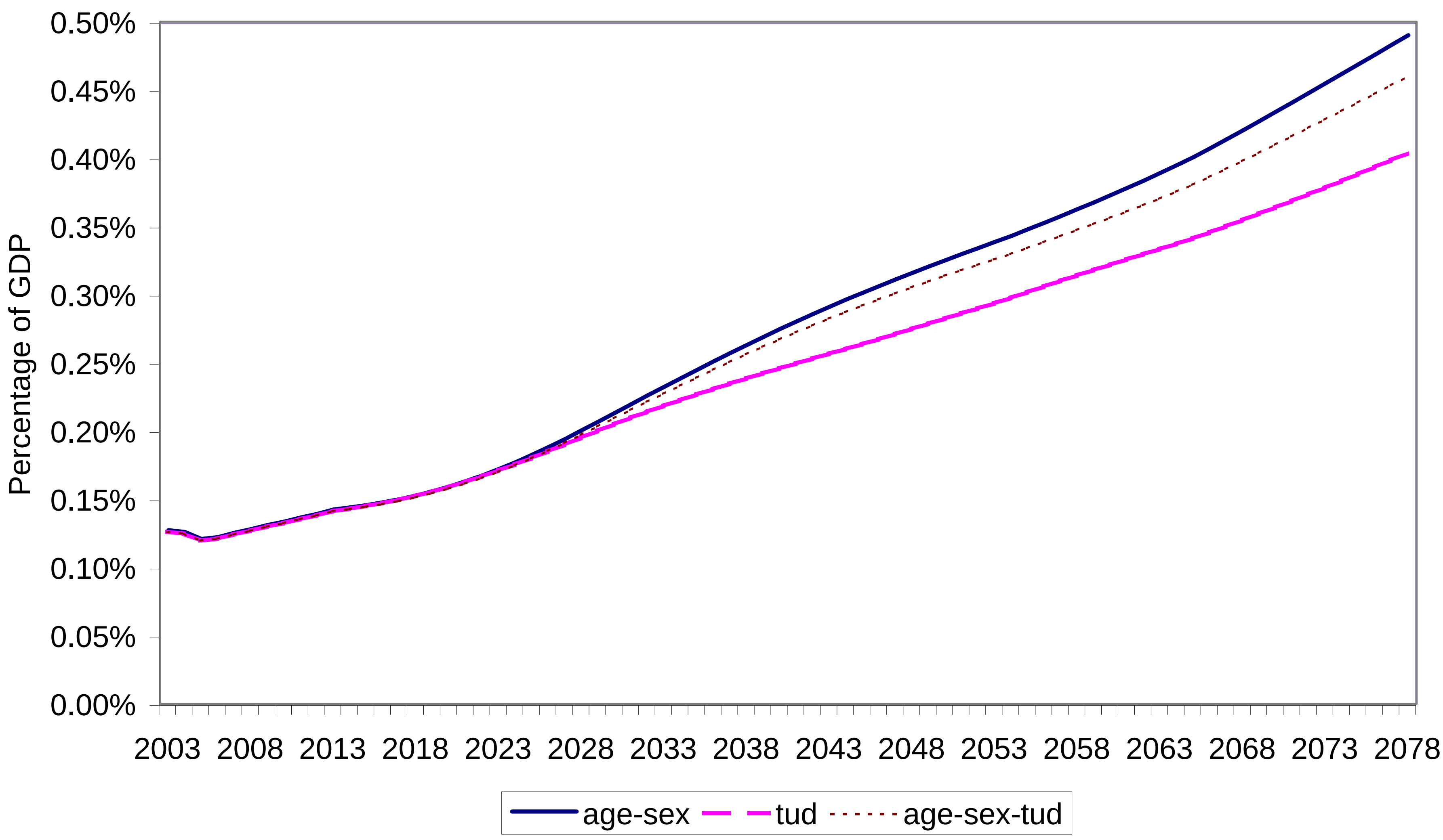

Figure 9
Home Health Costs as a Percentage of GDP

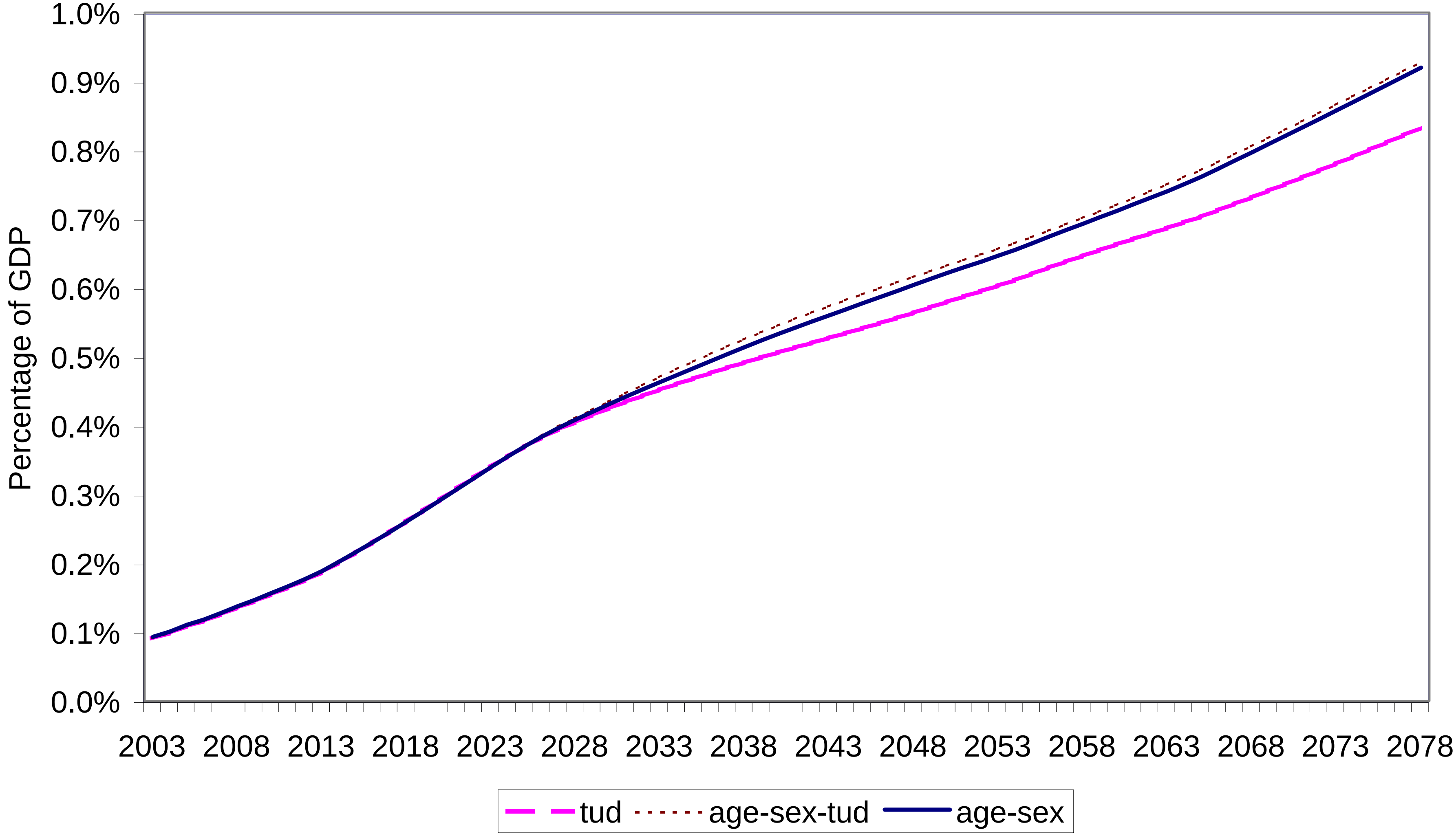

Figure 10
Outpatient Hospital Costs as a Percentage of GDP

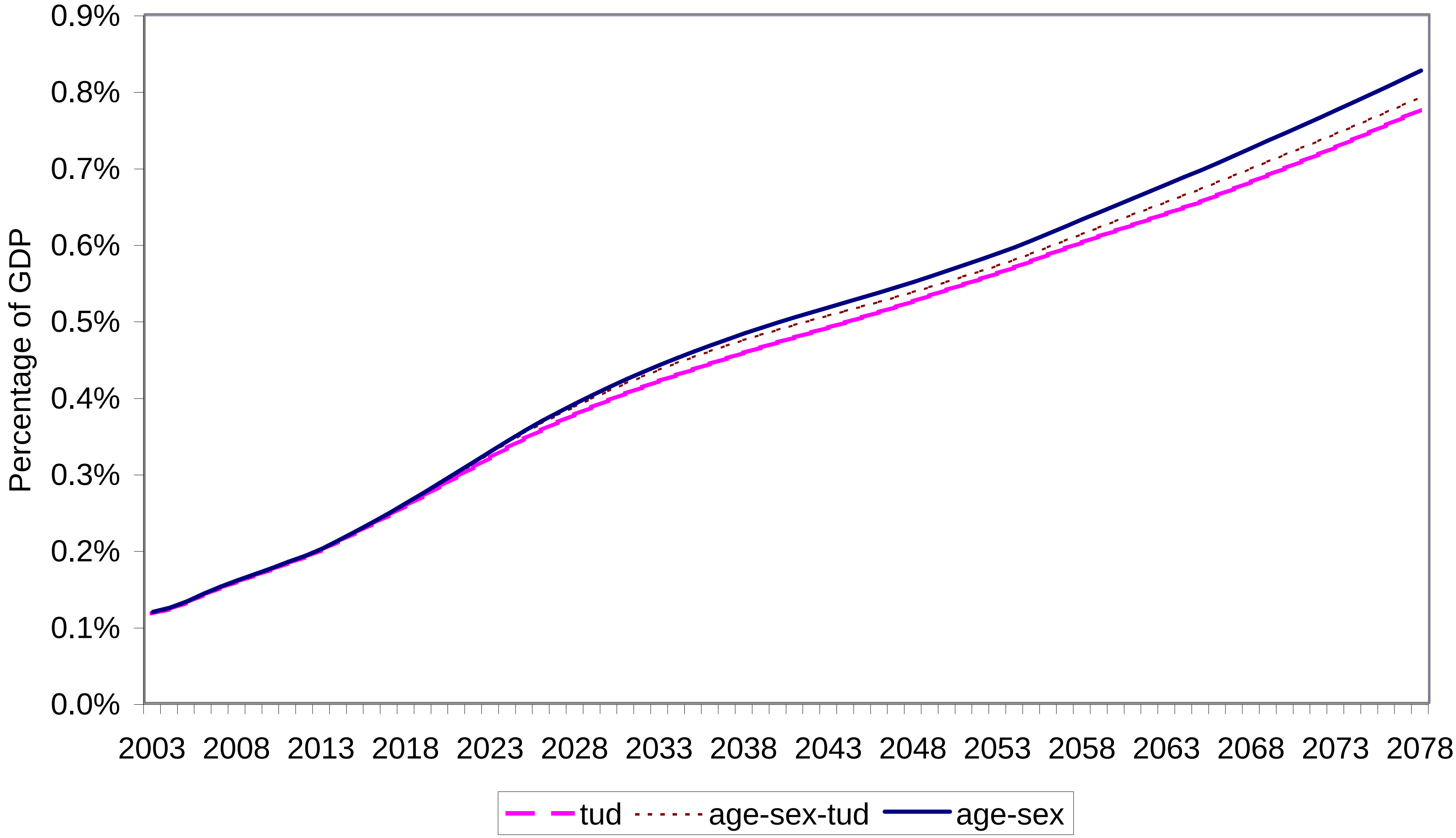

Figure 11
Physician and Other Part B Service Costs as a Percentage of GDP

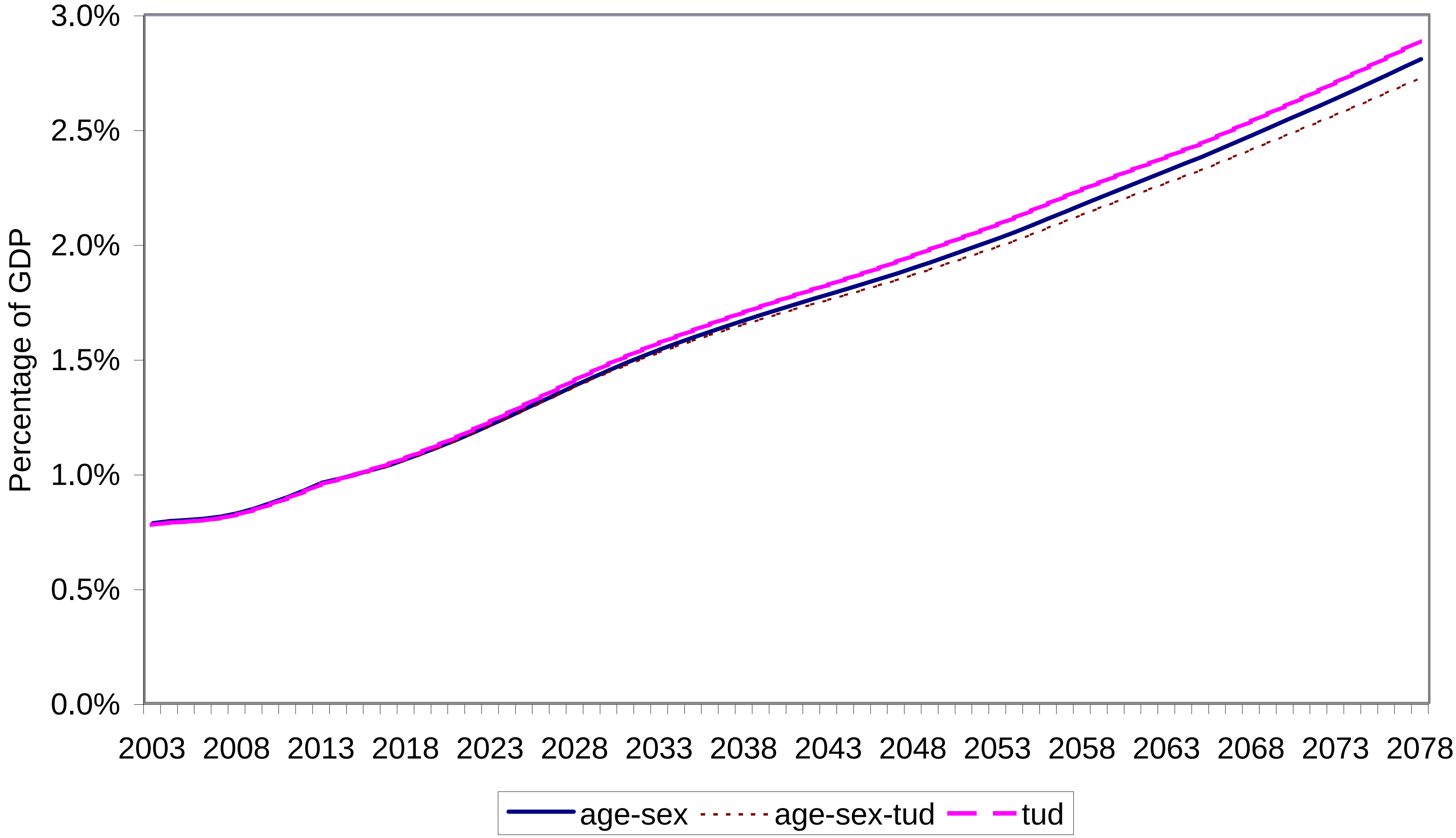

Figure 12
Medicare Managed Care Costs as a Percentage of GDP

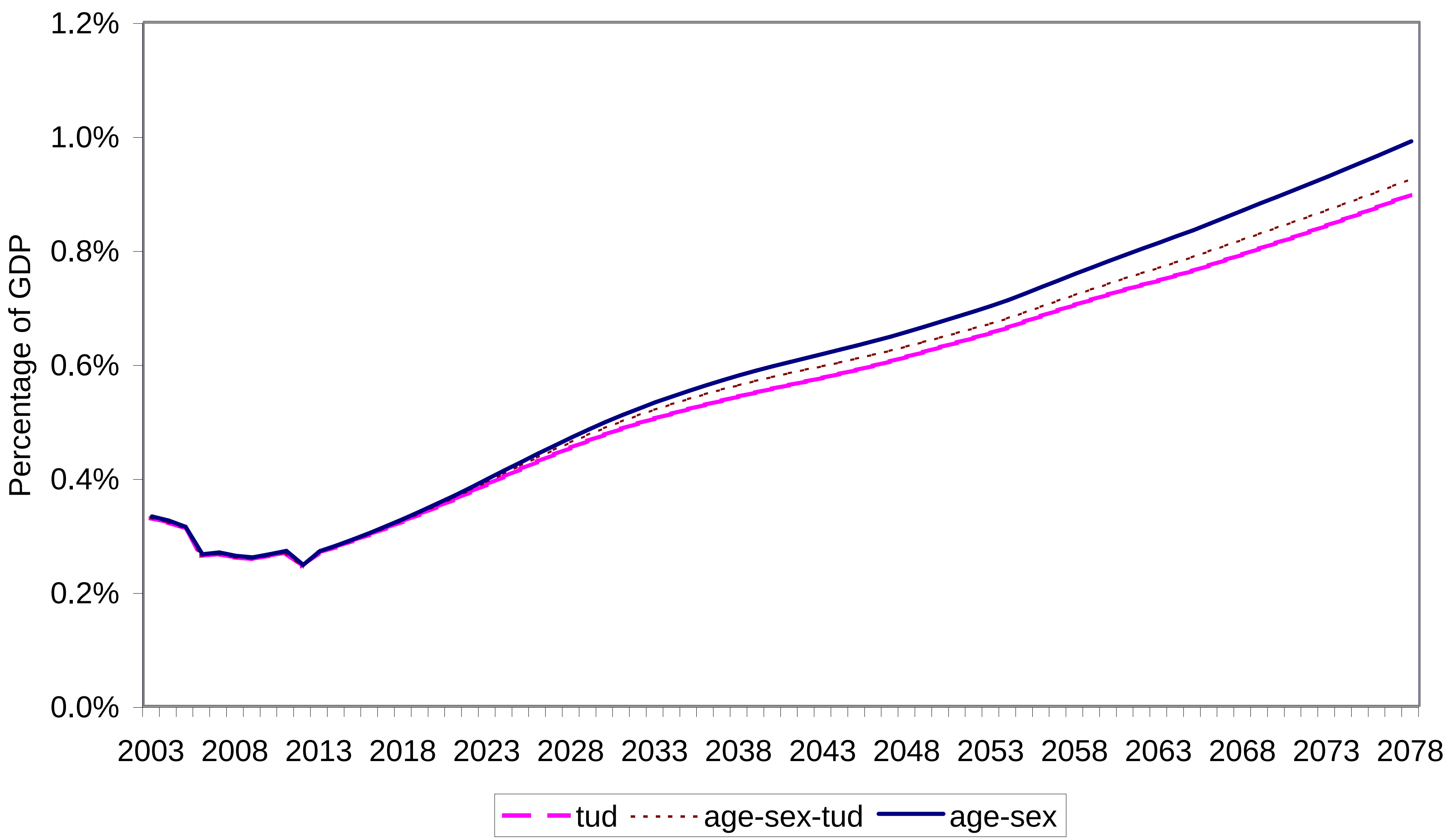

Figure 13
Category Specific Costs as a Percentage of GDP
Using an Age-Sex-TUD Index