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Uncertain Demographic Futures and Government Budgets in the US

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ABSTRACT

Recent decades have seen the emergence of massive public sector transfer programs in industrial nations. Because many transfers are age related, the population age distribution is a powerful influence on government budgets, and aging will be very costly. We construct stochastic projections of the budgets for the federal and state/local governments, disaggregated by program. These are driven by stochastic population projections and by stochastic projections of productivity growth and real interest rates. The demography influences budgetary outcomes through the age specificity of seven categories of tax payment and 28 government spending programs, as well as through public goods expenditures, debt service, and provision of congestible services. Forecasts of government deficits and debt under current tax and benefit trajectories make it clear that adjustments will have to be made in the future to avoid implausibly high and unsustainable debt levels. Subsequent forecasts are conditional on an upper bound to the federal debt/GDP ratio of 0.80. There is a very slight chance (2.5%) that the overall tax burden will barely rise, but most likely it will have to increase by 62% (from 24% in 1994 to 38% of GDP in 2070), and there is a slight chance that taxes would rise by 120% (to 53%). We have not yet explored adjustment through reduction of benefits. The expected GDP shares of child related expenditures and age neutral expenditures are both flat up to 2070. The expected share of old age expenditures, however, rises from 8.5% of GDP in 1994 to 22.5% in 2070. We find that there is a strong negative correlation between rates of expenditure on child-oriented programs and on elder-oriented programs, as one would expect given the importance of fertility for both outcomes. Thus focusing exclusively on the tax burden resulting from population aging could somewhat exaggerate the increases needed in the future. We also find that the rising cost of Social Security benefits (OASDI) accounts for only 28% of the rise in old age expenditures; fixing Social Security will not in itself fix the federal budget. The rising costs of health care will contribute even more, and must be addressed as well.

I. Introduction

Why are we as demographers making long term government budget projections? There are three reasons. *First*, the population size and structure exert powerful effects on many aspects of the budgets, particularly through the numbers of children, workers, and elderly. Long term population projections are a key factor in any long term fiscal projection. *Second*, demography is the only ingredient of long term projections about which one can realistically project more than a long term mean. The aging of the baby boom, continuing mortality decline, and continuing low fertility lead to population projections with real long term content, including turning points far in the future. Of course, none of these demographic trends is completely certain (Ahlburg and Vaupel, 1990), which leads to the *third* point. Demography has made more progress than other fields in explicitly incorporating uncertainty in long term forecasts. Since long term forecasts involve so much uncertainty that many doubt their utility, explicit treatment of uncertainty is desirable, and demographers are placed at least as well as other specialists to carry this out.

Nonetheless, there is a certain absurdity in focusing on a few demographic and economic uncertainties while treating all else as known with certainty, and then presenting probability intervals as if they had real meaning. There is also great uncertainty about future age-standardized health care costs, which will exert a powerful influence on most aspects of these forecasts. Future rates of disability for the elderly and near elderly are another key unknown. The structure of government programs will probably look quite different in ten years than it does now. The future progress of education in the US, of technological progress, of the quantity and characteristics of immigrant streams – all are important and uncertain, and the list could be extended indefinitely. What, then, is the point of this exercise? Several answers are possible, one of which is "Maybe there is none". Another is "We won't really know the possibilities until we have tried". But more positive answers are also possible: These estimates of uncertainty could plausibly be viewed as minima which are lower bounds for true uncertainty. Furthermore, the role of certain kinds of uncertainty can be largely eliminated by expressing results relative to GDP, rather than absolutely or per capita. The projection of population undergirds most long term economic projections, and certainly all fiscal ones. Assessing its uncertainty can only help. And uncertainty aside, our mean forecasts are themselves of considerable interest, because they have been done with more attention to the detailed age distribution of benefit programs than any previous forecasts, so far as we know.

An overarching question which stochastic forecasts such as these might eventually help answer is this: Given the context of uncertainty, should federal policy adopt a "wait and see" approach, since the extent of future problems is not yet clear, or should it prepare for the expected cost increases immediately by building up substantial trust funds in advance, held in the form of real assets? Fluctuating tax rates impose higher deadweight losses on the economy than a constant tax rate set at the average, since there are strong nonlinearities. Smoothing across variations in government expenditures therefore leads to efficiency gains. However, smooth tax rates may or may not be consistent with intergenerational equity.

A. Why Population Matters

Recent decades have seen the emergence of massive public sector transfer programs in industrial nations. Because many transfers are age related, the population age distribution is a powerful influence on government budgets, and aging will be very costly. In the next few decades, the US age distribution will be transformed by the aging of the baby boom generations. This aging process will have well-anticipated effects on the federal budget, particularly through the OASDI and Medicare programs, but also through Medicaid, Supplemental Security Income (SSI) and other programs. The effects of aging on other aspects of the federal budget, and on state and local budgets, are less well understood, and interact with uncertainty about future fertility. Will costs of schooling and other benefits going primarily to children vary so as to offset the public costs of aging, or will they also rise? And will population aging alter the balance of federal versus state and local spending?

In addition to these effects of population aging on costs of public services and transfers, demographic change will also affect the revenue base. Both the size and the age distribution of the working age population will change, and these effects may be worth taking into account, as well. Growth of the revenue base in relation to the size of the pre-existing government debt will also influence future tax rates.

B. Explicitly Incorporating the Uncertainty of Forecasts

Demographers have been working for many decades on the problem of producing long term stochastic population projections, including probability intervals for the quantities forecast. In recent years this work has intensified (Sykes, 1969; Keyfitz, 1981; Stoto, 1983; Alho and Spencer, 1985; Cohen, 1986; Alho, 1990; Lee and Carter, 1992; Tuljapurkar, 1992; Lee, 1993; Lee and Tuljapurkar, 1994; McNown and Rogers, 1992; Pflaumer, 1988; Lutz, 1996). An extensive review is provided in Lee (1996). A variety of approaches has been taken, including the use of expert opinion, ex post analysis of projection accuracy, Monte Carlo methods, and statistical time series analysis. In this paper, we build on the earlier work by Lee and Tuljapurkar (1994) to generate stochastic projections based on age distributed vital rates that are driven by statistical time series models fit to historical data.

There has also been increased interest in long term budget projections, with work by Auerbach and Kotlikoff (1994), and long term projections published in 1996 and 1997 by the Congressional Budget Office. These budget projections have generally been deterministic, but the Congressional Budget Office also included stochastic projections of Social Security finances based on inclusion of the Lee and Tuljapurkar stochastic population simulations. Holmer (1995a and b) has also generated stochastic projections of the long run finances of Social Security, based on treating the Trustees' high-low intervals for each assumption as implicit probability bounds, and then performing Monte Carlo simulation.

C. Dealing with Economic Uncertainty

In our projections, the only fundamental (as opposed to derived) economic variables that are treated as stochastic are the rate of real (age-sex adjusted) productivity growth and the real rate of interest, and these are treated as independent of the evolution of the population. Many others could, in principle, be modeled and forecast as random variables, including the rate of inflation, labor force participation rates, the rate of increase of health care costs, and the rate of unemployment. We have elected to keep the economic side of our analysis relatively simple. We have typically followed the intermediate assumptions of the Trustees in setting long term values for the variables treated as deterministic. It might be desirable to incorporate more general demographic influences on the economy, through savings behavior, investment, capital per worker, productivity growth, government debt, composition of demand for financial assets, and interest rates. Such an expanded endeavor would obviously involve many new assumptions and uncertainties, and we do not pursue it in this paper.

D. The Approach

This paper is the next step in a long term project by Lee and Tuljapurkar, with earlier contributions by Carter. The project started almost 20 years ago with the development of a new method for forecasting mortality, by combining statistical time series methods with a model of the age structure of changes over time in mortality (Lee and Carter, 1992). That was followed by a similar approach to forecasting fertility (Lee, 1993). These components were then used, together with earlier theoretical work by Tuljapurkar (1990), to develop stochastic forecasts of the population as a whole (Lee and Tuljapurkar, 1994). The stochastic population forecasts were then used to produce stochastic projections of the finances of the Social Security system (OASDI) in Tuljapurkar and Lee (2000). The only stochastic component of those projections was demographic. Subsequent work on long term forecasts of Social Security has incorporated stochastic models for productivity growth rates and real interest rates, as well (Lee and Tuljapurkar, 1998a, 1998b). The present paper incorporates that work on Social Security in a broader treatment of government budgets. It draws on related deterministic budget projections done as part of a project to assess the fiscal impacts of immigration (Lee and Miller, 1997). In many respects, we have tried to follow the assumptions and procedures of the long term budget projections published each year by the Congressional Budget Office. Where our approach differs, we generally spell out the rationale and procedures.

It would be absurd to argue that public programs in the US will remain as they are now, in terms of benefit structures, for the next 75 years. We do not know what programs will look like decades from now. One might argue that even though the details of program benefit structures will surely change radically, the overall age distribution of the aggregate of program benefits may remain fairly similar. Even this weaker assertion would be difficult to defend, however. For example, it is possible that the retirement benefit of the Social Security system will be to some degree replaced by private individual retirement accounts, as in Chile. Then retirement benefit payments to the elderly would vanish from the government budget, dramatically altering the age-shape of federal benefit payments. For the most part our projections are made conditional on a set of assumptions about the policy environment, often that the current benefit structures persist. Our projections can therefore be viewed as spelling out the long run future implications of different policy regimes, including adaptive policy regimes.

II. Population Projections

The population projections which underlie the budget projections have been described in detail elsewhere (Lee and Carter, 1992; Lee, 1993; Lee and Tuljapurkar, 1994), so only a short summary will be provided here. The basic strategy is to develop one parameter families of model age schedules for fertility and mortality (to use demographers' terminology). Let m(x,t) be the death rate for age x and time t. Then the descriptive model for mortality is: $\ln[m(x,t)] = a(x) + k(t)b(x) + \varepsilon(x,t)$, where a, b, and k are estimated coefficients, and ε is the error. $a(x)$ describes the average shape across ages of the death rates, while $b(x)$ describes the rate at which the death rate at age x changes when the overall level of mortality, indexed by $k(t)$, changes. The estimates of $k(t)$ form a time series over the sample period in which mortality is observed, which is modeled and forecasted using statistical time series methods. For the US, a random walk with drift fits the series well. The mean forecast from this method is for sexes-combined life expectancy in 2065 of about 86 years, roughly twice the gain in life expectancy that is forecast by the Social Security Actuaries (Trustees' Report). However, differences in the age distribution of the projected declines tend to offset some of the effects of this more rapid mortality decline in relation to the Trustees' mortality forecasts.

Fertility is modeled, estimated, and forecast in a similar way, except that in this case, the logarithmic transform is not used, and we specify a longer term mean for the stochastic process (see Lee 1993). For the US, we have taken this to be 1.9 for the TFR, consistent with the assumption used by the Actuaries of the Social Security Administration (Board of Trustees, 1996). The statistical analysis then provides estimates of the variance and autocovariance of the fertility process. Immigration is set deterministically at the level assumed by the Actuaries, which is 900,000 per year. While it could be modeled in a way similar to the vital rates, the fact that it depends to a considerable extent on policy decisions puts it in a different category.

With stochastic models for fertility and mortality, and a deterministic assumption about immigration, and with initial values for the population size and age-sex distribution, it is possible to construct a projected "sample path" through stochastic simulation. (An analytic solution for a quadratic approximation to the moments of the distribution of the population variables is also given in Lee and Tuljapurkar, 1994, but for present purposes the stochastic simulation is far easier to use.) A set of 750 sample paths (individual stochastic projections) is built up, where 750 was chosen by studying the convergence of the moments calculated from these simulations. This set forms the demographic basis for more comprehensive stochastic simulations, along lines described next.

III. The Age Structure of Benefits

Some government transfer programs are targeted to the needy, and some are targeted to specific age groups. Of those targeted to the needy, some end up nonetheless being used primarily by certain age groups. In any event, people in the working ages receive a relatively low level of transfers, on average. It is children and the elderly that receive the lion's share. To illustrate this point, Figure 1 plots the total across all programs of the cost of benefits received by the average person at different ages in the US. There is a base line for all ages reflecting non-age-specific congestible services provided by the government, such as fire and police protection, roads, libraries, and so on. Our main interest, however, is in programs that have an uneven age incidence, either by design, as with Medicare, or by accident. It can be seen that children aged 5 to 22 are recipients of major benefits, primarily public education. Levels of receipt are lower for ages 23 through 55 or so, and then begin to turn up sharply, with the steepest increase at 62 years, the earliest age at which one can take Social Security retirement benefits. The major benefits received in old age include Social Security, Medicare, Medicaid (particularly for the oldest old in nursing homes), and SSI.

It is these strongly age-structured benefits which make demographic trends centrally important for government budgets. However, governments provide other services which do not depend on age in any obvious way. Some of these are public goods, such as the military. By definition, the cost of providing a constant level of service for a pure public good is invariant to the size of the population. Nonetheless, we follow the Congressional Budget Office in projecting that military expenditures remain a constant fraction of GDP, and therefore grow as it grows. This could be explained as a response to the falling per capita price of providing a given level of service. The cost of servicing the existing level of national debt does not depend on the size of the population, so a larger population can share the burden of paying interest on it.

In addition, there are many government services for which maintaining a constant quality requires increasing expenditure more or less in proportion to the size of the population. We assume that expenditures on such services grow both because of population growth and also because of growth in per capita income. Therefore they, also, are assumed to grow with GDP.

IV. Economic Projections

Our raw measure of productivity growth is output per hour of labor. We refine this by adjusting for the age-sex composition of the labor force, weighted by the average wage rate for each characteristic. This adjustment makes relatively little difference. For the interest rate, we have used the time series for the special Treasury Issue for Social Security, which is based on an average of rates for bonds of differing terms. This synthetic rate has averaged 2.3% per year over recent decades, in real terms. Both the productivity growth rate and the interest rate are modeled as processes with long term means constrained to equal the values in the Actuaries' Intermediate Forecast (Board of Trustees, 1996). The variances and autocovariances are estimated from the data. We did not find these series to have significant covariances, so they were modeled as independent. In future work, we plan to develop better integrated models of these series, based on the work of Frees et al. (1997). We may also distinguish between rates of return earned by Social Security, and rates of return earned by private purchasers of Treasury notes.

V. Detailed Assumptions and Procedures

Our baseline policy assumption is that the federal budget is adjusted through changes in the level of taxes to maintain a given level of federal debt to GDP. Benefits remain as they are now defined to be (including scheduled changes in the Social Security normal retirement age). State and local aggregate budget also maintains a constant debt to GDP ratio at its current level.

Given this setup, the trajectory of government debt is fully determined. Our interest focuses on the time paths of expenditures for various programs and various levels of government, and on the trajectories of taxes at the federal and state/local levels, for OASDI, and for other programs of interest. There will be a great deal of uncertainty associated with each of these projected trajectories.

These projections involve a large number of detailed assumptions and calculations, which we will briefly describe. Details can be found in Edwards (1998) which is available on request. In general, we have followed many of the procedures used by the Congressional Budget Office (1996) in their long term projections.

A. Forecasts of GDP

GDP is calculated by applying an estimated age schedule of earnings to the evolving population age distribution. The resulting product represents the demographic contribution to economic growth. A constant of proportionality is chosen to adjust the product so that it matches actual initial GDP. Thereafter, the adjusted demographic product is inflated by the level of productivity, given by the stochastic forecast. Recall that productivity growth was measured in an age standardized way. This procedure reinserts the influence of changing age distribution on output by way of the demographic product. This procedure also implies that labor earnings are a constant share of GDP, as are earnings of capital. The procedure implicitly assumes that labor force participation rates remain constant, with declines for older males offset by increases for females.

In our forecasts (not shown here) the expected value of GDP grows from $6.74 trillion at the 1994 baseline to $24 trillion in 2070 (in 1994 dollars), for an average growth rate of 1.67%. Recall that the average productivity growth rate is assumed to be 1% per year; the difference, or 0.67%, reflects growth in the size of the labor force. There is enormous uncertainty about the amount in 2070, with the 95% range bounded by $8 trillion below and $48 trillion above. The upper bound corresponds to an average growth rate of 2.6% per year, and the lower bound to 0.2%. Because of this extreme uncertainty, it makes little sense to present results other than in relation to GDP.

B. Forecasts of Benefits

For most programs, we begin with the cross sectional age-specific benefit profile estimated from Current Population Survey data, and assume that this schedule rises with the productivity growth rate. Total expenditures on such programs will then be determined by each year's population size, population age distribution, and level of productivity. This is true for the following programs: Earned Income Tax Credit, College Education, K-12 Education, School Lunch, Food Stamps, Energy Assistance, Direct Student Aid, Public Assistance, SSI, Federal Retirement, Military Retirement, Railroad Retirement, Public Housing, Rent Subsidy.

The main exceptions to this rule are as follows.

a) The age profile of costs for all health programs rises by the productivity growth rate plus an additional amount. This additional amount was projected based on assumptions in past reports of the Medicare Trustees, which the Congressional Budget Office also used. In particular, real per enrollee health costs were calculated from Trustees of HI (1996), which implies that they will rise more rapidly than productivity growth, by an additive amount which is initially 0.0472 per year, but which declines to near zero by 2015. This is a fairly low forecast of excess growth in health costs per elder in comparison to others. Medicaid and SMI benefits are projected subject to the same excess growth rate for the age profile of health costs.

   It is important to note that health costs in the last year of life are on average about 15 times as great as the health costs for someone of the same age who is not about to die (Miller, 2001; Lubitz, Beebe and Baker, 1995). Health costs increase with age largely because the proportion of people in their last year of life itself increases with age, due to rising mortality. Mortality decline may reduce the health care costs at any given age by reducing the probability that anyone at that age is dying. Consequently, health care costs may be temporarily lower in the aggregate when mortality declines more rapidly, because in a transitional stage, the costs are pushed to a later calendar year. Miller (2001) takes explicit account of these effects and finds that the pace of mortality decline has virtually no effect on Medicare costs over the next 75 years. Our projections for Medicare and SMI incorporate this effect, by imputing costs separately to those in their last year of life, those one to three years from death, and all others.

   It is likely that Medicaid expenditures for long term care depend in a similar way on proximity to death, but the research has not yet been done on this. We examined institutional Medicaid usage rates, controlling for age, and found that they had been slowly declining over the past 25 years. We have assumed that the decline continues, reflecting the documented improvements in measures of functional status (Manton, Corder, and Stallard, 1997).

b) The age profile of Social Security benefits is determined in a complex manner based on separate work (Lee and Tuljapurkar, 1998a, 1998b), and reflects the influence on benefits of the past history of productivity growth, and the influence of the planned increase in the normal retirement age.

c) A number of programs grow as a constant share of GDP. These include all public good expenditures, congestible good expenditures, outlays to manage the Unemployment Compensation Trust Fund, and incarceration costs (incarceration costs should probably be projected using an age profile, however). Although constant quality services from a public good have zero marginal population cost, in fact higher quality services are chosen over time as the per person cost of services drops with population growth.

C. Taxes

With No Budget Adjustment: For the case of no budget adjustment for balancing, federal and state income taxes and sales taxes are projected by applying an age profile to the population age distribution and scaling by productivity growth. Property taxes grow according to an age profile which is raised or lowered to generate revenue equal to the costs of K-12 public education. Corporate income tax, excise taxes, and all other taxes grow in proportion to GDP. Payroll taxes for OASDI follow an age profile and productivity growth, but are adjusted to reflect the planned increase in the normal retirement age. We implicitly assume that the real income truncation point for OASDI taxes will be raised with real productivity growth. Medicare costs are assumed to be paid out of general federal tax revenues; we have not tried to model this system separately. In every case, we can allocate tax payments to specific age groups.

With Budget Adjustment: Usually, however, we assume that budgets are adjusted to achieve balance according to some criterion. This is necessary if we are to assume that there is no feedback to the interest rate and the productivity growth rate, and we also believe it is a sensible assumption both from the point of view of both economics and politics. Our balancing assumptions are as follows:

a) The Social Security system is assumed to keep the payroll tax rate at 12.4% so long as the reserve fund has an amount equal to at least 100 percent of next year's total outflows. Note that this means that taxes will begin to rise as the trust fund is depleted, so as to prevent the fund from falling to zero. Planners are assumed to look ahead five years in setting the current payroll tax rate. Note that this means that the 75 year forecast period cannot end with the rapid depletion of the trust fund and a big discrepancy between revenues and expenditures, as it does in the standard Trustees' Report projections.

b) The federal government targets the net debt-to-GDP ratio. Net debt is defined as all federal debt not held by Social Security. When net debt threatens to rise above 0.8 of the level of GDP, taxes are adjusted that year in equal percentages across the board (except for OASDI taxes, which are handled separately) so that the debt exactly becomes 0.8 of GDP. In each subsequent year, taxes are adjusted similarly to keep debt/GDP exactly at 0.8. This rule constrains the federal deficit (exclusive of OASDI net revenues) at a level just sufficient to keep the net debt growing at the same rate as GDP growth. Policy makers are assumed to project the debt to GDP ratio five years in the future, and set current taxes accordingly.

c) At the state/local level, it appears that trust funds for various insurance and retirement programs are fully funded (on average), so budgetary pressures from population aging are light. Because the funding appears to be adequate, we treat these programs as outside our calculations of benefits and taxes. We assume that states and localities alter their taxes by equal, across-the-board factors in order to maintain a net debt-to-GDP measure of 0.03. Net debt held by states and localities is defined as their gross debts, all bills outstanding, minus their various pools of asset, but not including the various trust funds.

VI. Problems with Current Version

We are aware of certain problems with our analysis. One serious problem arises because we assume that the debt to GDP ratio is fixed at 0.80, once that level is attained. This constraint is observed by adjusting the non-OASDI federal tax rate each period so as to keep the ratio constant. However, the real interest rate is highly variable in our simulations, and we have implicitly assumed that the entire debt is refinanced every year. For this reason, very large and volatile adjustments of the tax rate are required each year to offset the interest payments that must be made. Our algorithm produces unrealistically volatile tax rates for several reasons. First, only a portion of the debt is financed each year at prevailing interest rates; the rest is held in bonds of longer maturities. Second, most of the variation in real interest rates arises from the volatility of inflation, not that of nominal interest rates. But we do not incorporate inflation as a separate variable. Third, tax rates are not varied on an annual basis. As a temporary expedient, we have replaced the current real interest rate by a one-sided moving average of current and past rates, with weights equal to average maturity shares of bonds outstanding.

This work borrowed heavily from earlier work on forecasting Social Security finances (Lee and Tuljapurkar, 1998a, 1998b), including the time series models for the interest rate and productivity growth rates. We believe we can improve on these time series models by building on the work of Frees et al. (1997). This work also models inflation as a component of an interdependent system.

The fiscal landscape has shifted frequently and often dramatically since 1994, the launching point of our forecasts in this paper. We have not accounted for several notable developments that are sure to bias our point estimates but will probably leave higher moments relatively unchanged. These include the surpluses that paid down much federal debt in the late 1990s, the increase in federal spending after 9/11, the tax cuts of 2001 and 2003, the introduction of the Medicare prescription drug benefit in 2006, the fiscal stimulus bills of 2008 and 2009, and the ongoing financial sector and mortgage bailouts.

VII. Results with No Budget Adjustment

We would like to begin with the assumption that the current tax and benefit structure remains as it now is, except for changes that are currently planned, such as the increase in the normal retirement age. However, we have not quite been able to do this, because for temporary programming reasons, all the runs in this paper assume that the Social Security system (OASDI) is "fixed". By this we mean that a trust fund equal to 2.5 times the level of the following year's expenditures on benefits is achieved and maintained. Payroll taxes are adjusted so as to maintain this ratio. In our runs with "no federal budget adjustment", therefore, OASDI is nonetheless adjusted. In these runs, it is only the non-OASDI portion of the federal budget that is not adjusted.

Figure 2 shows the mean and 95% probability intervals for forecasts of the Debt/GDP ratio under the assumption of no adjustment. Starting at 0.6 in 1994, the expected value of this ratio rises steadily to 8.0 in 2070. We do not believe that such a huge increase is possible, and if it were, it would entail large increases in the real interest rate at which funds could be borrowed by the government, whereas we have assumed that the real interest rate has a long term mean of 2.3%. This forecast also shows a 2.5% chance that the ratio would climb to at least 20! The point of this conditional forecast is to establish that the condition – no budget adjustment – is simply not realistic. Even under the most optimistic conditions (2.5% probability bound) the ratio would rise to 2.4.

Forecasts of expected federal real interest payments relative to GDP trend upwards from an initial expected value of 1.5% (nominal interest payments are higher) to 16.5% in 2070. Under the budget adjustment regime, however, expected real interest payments rise only to 2.2% of GDP. All these ratios of interest payments to GDP would be about twice as great if expressed in nominal terms, and if the rate of price inflation were 2% per year.

VIII. Results with Tax Adjustment

We believe it is realistic to assume that the federal budget will be adjusted in such a way that the debt/GDP ratio will be constrained. In the forecasts reported here, we assume that the entire adjustment is made by tax changes, while the structure of benefits is left unaltered. One could also do the forecasts making the opposite assumption, that taxes are unchanged and benefits bear the full cost of adjustment.

In our forecasts, following the budget adjustment rules, the debt/GDP ratio of 0.8 is reached by 2002 in 2.5% of the sample paths, and at least as late as 2030 by 2.5% of the sample paths.

Figure 3 plots the ratio of total taxes (state, local, OASDI and other federal) to GDP. Total taxes are currently 24% of GDP. The expected tax share will rise at an accelerating rate as the baby boom generation retires, reaching 34% of GDP by 2035 when its retirement is complete. However, the expected share will continue to rise, reaching 38.5% by 2070, an increase of 62% (1.62=38.5/24). The lower and upper 95% probability bounds for the total tax share in 2070 are 28% and 50%.

At the state and local level (SL), expenditures are primarily for education, and therefore fertility is centrally important. There is very little uncertainty about the number of school age children until five years into the forecast, when the first projected births would be entering kindergarten. This shows up clearly in the forecasts shown in Figure 4.

IX. Social Security (OASDI) and Medicare

Figure 5 plots the payroll tax rate for OASDI that is implied by our rule that the system move towards a reserve fund equal to 100% of the next year's expenditures. The initial level is 12.4%, as set by current law. The tax rate on the mean trajectory rises slowly, reaching a level of 17% by 2035, but continuing to rise to 21% in 2070. This is a substantial increase, but it is quite consistent with the Trustees' projection that under the intermediate assumptions, the cost of the program in 2070 will be about 19% of payroll. Our figure is slightly higher, probably because we project more rapid mortality decline. But the big difference between the Trustees' calculations and ours is in the question asked. We only raise the payroll tax when necessary, and do not seek to accumulate a large reserve fund. The level of reserve fund we maintain is roughly equal to the maximum ratio achieved under the intermediate assumptions. The Trustees, by contrast, ask by how much the payroll tax would have to be raised today to achieve long run balance. They find that a 2.2% increase would do the trick, which would lead to the accumulation of a larger fund, but which would also leave the system losing money rapidly at the end of the period in 2070. Under similar assumptions, our forecast would give results similar to the Trustees, and vice versa.

Figure 5 also shows that there is a 2.5% chance that the payroll tax would need to rise by only 1%, and a 2.5% chance that it would need to rise to at least 33%. Other experiments, not shown here, also reveal that raising the payroll tax rate by 2% today would leave a 75% chance of trust fund exhaustion before 2070. To achieve an exhaustion probability as low as 5% would require an immediate payroll tax increase between 5% and 6% (Lee and Tuljapurkar, 1998a, 1998b). Fortunately, there is no need to pick an increase today that would remain fixed henceforth; policies with an adaptive element are also possible.

Figure 6 shows that the expected level of expenditures on Medicare Part A (Hospital Insurance, or HI) as a share of GDP rises rapidly from about 2% today to about 5% in 2035, continuing up to 6.4% in 2070 where it is still well below the level of outlays for OASDI at 8.6% of GDP. But taken as a whole, Medicare is likely to exceed OASDI in costs in the long run. Medicare Parts B (Supplementary Medical Insurance, or SMI) and D (the prescription drug benefit, which we do not forecast) are each projected to cost about 2% of GDP by 2070 in the intermediate scenario presented by the Medicare Trustees (2008). Although an underestimate, our forecast is more interesting for what it reveals about the uncertainty. Partly because we treat the trajectory of costs per enrollee as deterministic, there is little uncertainty in Part A until projected births begin to enter the labor force in substantial numbers in the 2020s. Thereafter the probability interval opens rapidly, until by 2070 it ranges from 3.9 to 10.5%.

Even after removing OASDI and Medicare, other federal expenditures still rise in expected share from just over 11% of GDP to just under 16%, presumably reflecting increasing costs of other programs serving the elderly, such as Medicaid and SSI.

X. Results by Age

We have taken two different approaches to disaggregation by age. Fortunately they yield nearly identical conclusions. In the first approach, we simply categorize government programs as oriented towards youth, towards the old, or as age-neutral. For each program, we calculated the average age at which its services would be received in a stationary population. These average ages then provided an objective criterion for classification. On this basis, youth oriented programs were defined to include food stamps, school lunches, direct student aid, public assistance, K-12 public education, college education, and non-institutional Medicaid. Programs oriented towards the old include OASDI, Medicare (excluding Part D, the new prescription drug benefit, which we do not forecast), SMI, SSI, institutional Medicaid, Federal Retirement, Military Retirement, and Railroad Retirement. For age neutral expenditures, we have the Earned Income Tax Credit, energy assistance, rent subsidies and public housing, plus all congestible public services and all public goods (for which we include the per capita cost, even though the marginal cost is zero).

When programs are grouped in this way, and projected (see Figure 7), we find that for expected values relative to GDP both youth programs and neutral programs are virtually flat at 6.5 and 7.5% respectively. Old age programs, however, rise from 9.5% of GDP currently to 21.4% in 2070. This is a striking demonstration of the importance of population aging for public budgets.

It is also interesting that the probability fans for the three groups have very different shapes, as seen in Figure 8. The share of age-neutral expenditures is virtually constant and involves little uncertainty, because the congestible programs are projected as a constant share of GDP, and only the earned income tax credit varies somewhat with age. The share of youth spending is highly certain for the first five years, before the first projected births reach school age. After this, the fan opens up rapidly as more births enter childhood, but the edges of the fan become parallel, since mean fertility together with immigration leaves a roughly constant expected number of births. For old age, the fan is initially tight, since only uncertain survival enters in. But once the uncertain number of projected births floods the labor force, uncertainty begins to grow rapidly mainly due to uncertainty about the labor force and GDP. The growth of spending on all government programs combined, shown in Panel D, is very similar to the growth of taxes shown earlier in Figure 3.

After 2035 or so, there is a great deal of uncertainty about expenditures for both youth and the elderly. Common sense suggests that some of this uncertainty should cancel in the aggregate, since high fertility and larger labor force would lead to lower expenditures on the elderly relative to GDP. Figure 9 plots the correlation for each year between the share of GDP going to programs for the elderly and the share going to programs for children. The correlation is near zero for the first 20 years, when uncertain fertility has not yet had a chance to affect the size of the labor force (the reason for the spike in 1998 is not clear). After this it falls below -0.5 by 2040, consistent with expectations. This suggests that focusing exclusively on trends in the old age dependency ratio, for example, without taking into account the fiscal effects of the fertility trends that give rise to those ratios, could lead to unduly pessimistic conclusions.

We have also segregated expenditures on the elderly more precisely by examining expenditures by all programs on people who are 60 or over. This method of accounting will disregard the OASDI benefits that go to child survivors, young widows, or young disabled workers, and include only the benefits received by the elderly. Similarly, Medicaid expenditures on the elderly will be counted, as will food stamps, energy assistance, public housing, and all other benefits that sometimes go to the elderly. Figure 10 plots the result of this approach. It shows the growth in total expenditures from 8.6% to 21% of GDP, an increase of 144%! It also shows the contribution of each one of many programs to this overall increase, in a cumulative line graph.

The increase in spending on OASDI for the elderly accounts only for 31% of the total increase in spending on the elderly as a share of GDP. Even excluding the new prescription drug benefit, health costs, which increase by a factor of 3.75, account for 56% of the total increase, or nearly twice as much. That leaves 13% for all the other programs combined (federal and military retirement programs, and SSI).

XI. Conclusions

It is important to keep in mind that all these forecasts are conditional on the current structures of tax and benefit programs as of the mid 1990s. Since then, government fiscal policy has dramatically altered course several four times, and it will doubtless change again in the future. Although our forecasts should not be interpreted unconditionally, we believe they remain highly informative of many of the long-term fiscal challenges posed by population aging.

Several of our main findings follow. Some apply to the expected forecast trajectories, and could be generated by a conventional intermediate scenario projection with suitable disaggregation. It is these specific results that will be most sensitive to changes in the fiscal landscape since the mid 1990s. Other findings derive from the stochastic nature of the forecasts, and they are less likely to depend on recent policy adjustments.

- By our measure, current total taxes were 24% of GDP in 1994. The expected tax share will rise at an accelerating rate as the baby boom generation retires, reaching 34% of GDP by 2035 when its retirement is complete. However, the expected share will continue to rise, reaching 38.5% by 2070, an increase of 60%. The lower and upper 95% probability bounds for the total tax share in 2070 are 28% and 50%.

- Fixing Social Security (OASDI) is only a part of fixing the overall federal budget. Population aging will also have dramatic effects through other programs such as Medicare, Medicaid, SSI, and other retirement programs, particularly as aging interacts with rising medical costs per enrollee. Growth in OASDI costs account for at most 31% of the total increase in public expenditure associated with aging, while the responsibility of rising costs of health care is nearly twice as great.

- The strong influence of population aging on government budgets is very clear. Expected expenditures on children and on age-neutral services, as a share of GDP, are projected to remain flat, at about 6.5 and 7.5% respectively. Expenditures on the elderly are projected to rise from 9.5% today to 21.4% by 2070, or by 125%. The 95% probability band includes increases to only 13%, or to as much as 35% of GDP, but these forecasts do not include the recent prescription drug expansion of Medicare, which alone is expected to cost 2% by 2070.

- Future expenditures on children and on the elderly (relative to GDP) are moderately negatively correlated in the 21st century (ρ = -0.5 to -0.6 after 2040), since sustained low fertility both reduces expenditures on children and reduces the size of the labor force relative to the number of elderly. Our forecasts account for this correlation, but others that focus only on the old-age dependency ratio may overlook it and thus overstate fiscal pressures.

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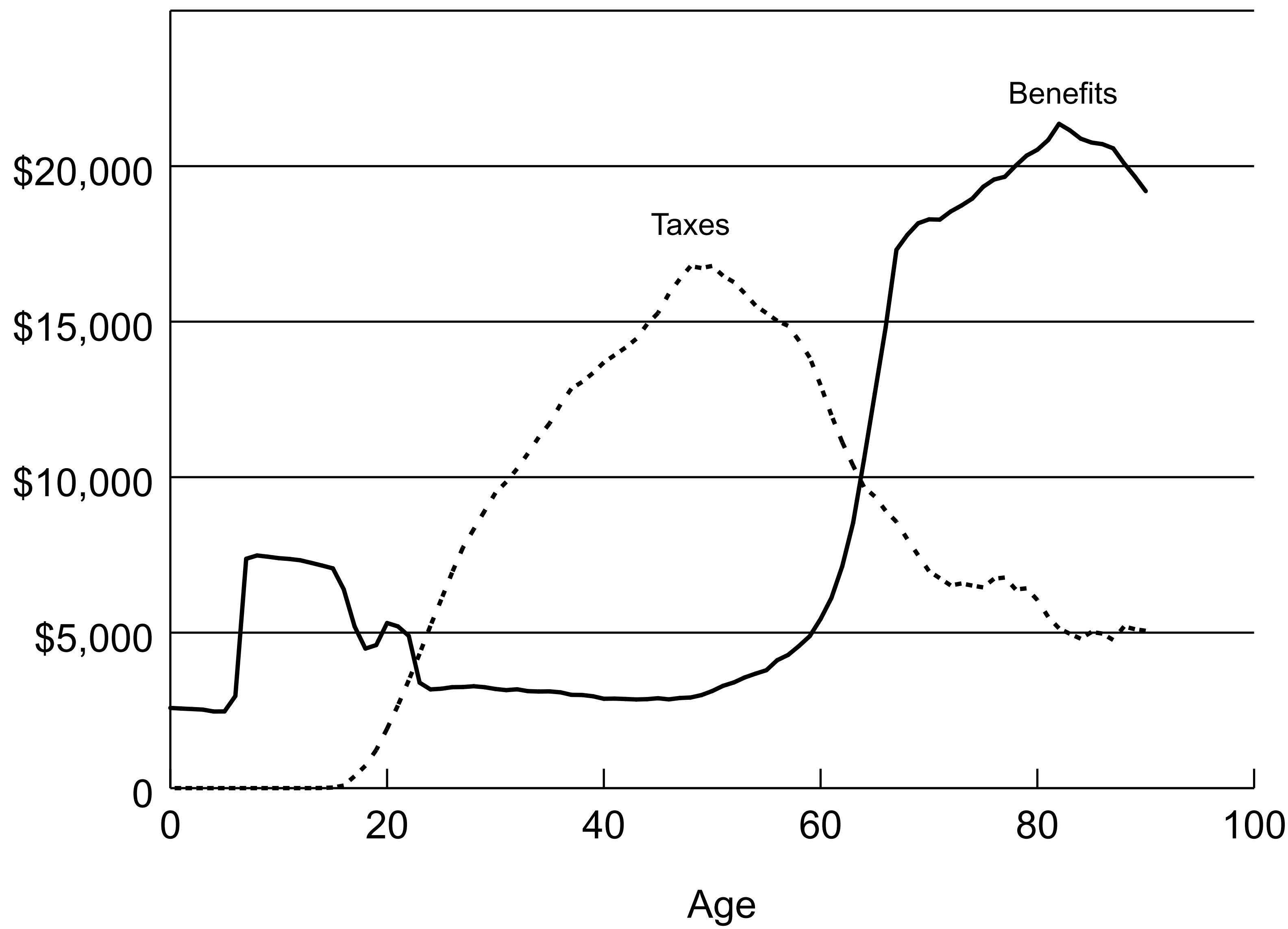
Figure 1. Cross-Sectional Age Profiles for Benefits and Taxes



Note: These data are taken from the 1994 and 1995 March Current Population Survey. Benefits include a per-capita share of congestible goods.

Figure 2: Forecast of Debt to GDP Ratio With No Budget Balancing
(Mean and 95% Probability Interval, 1994 to 2070)

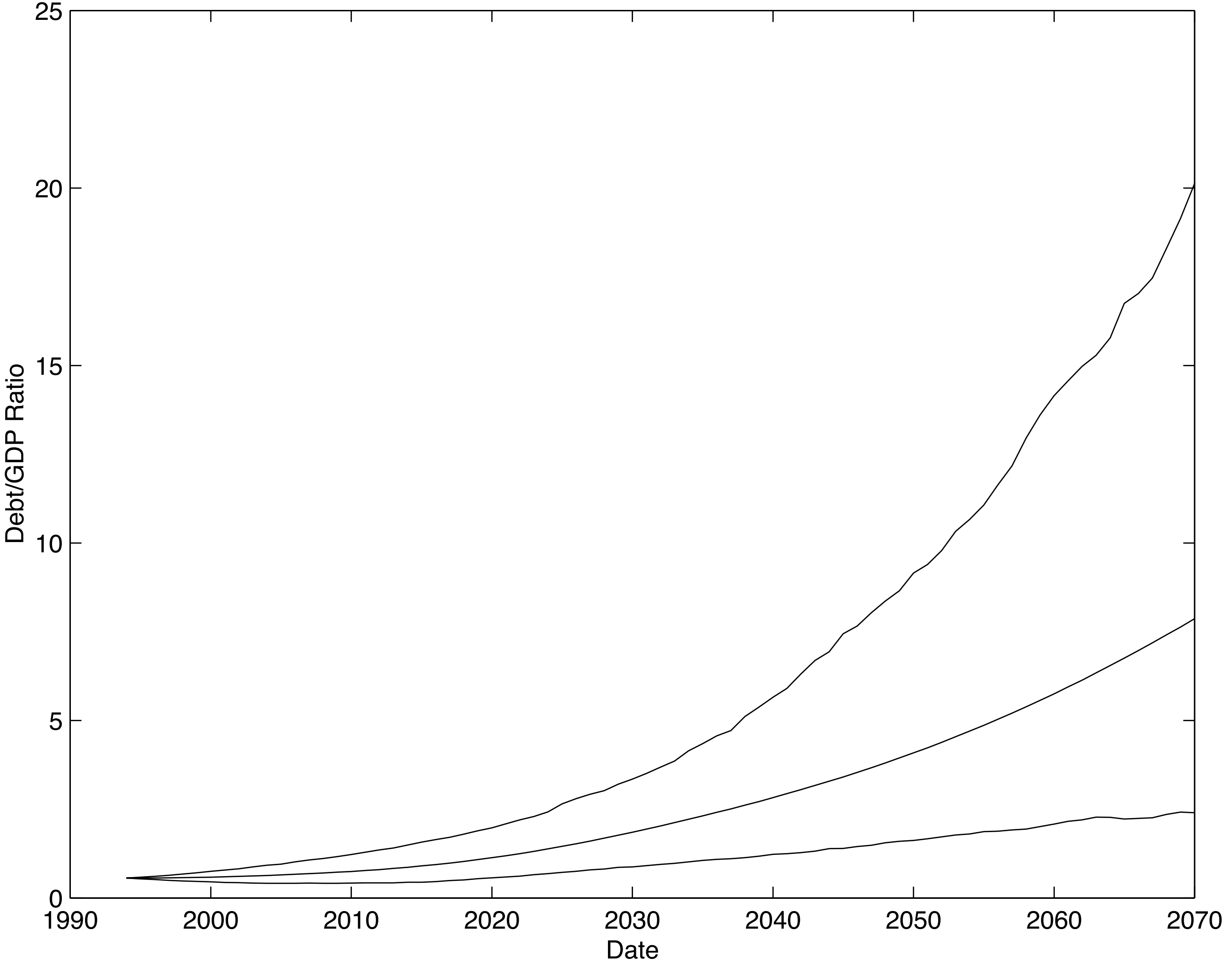


Figure 3: Forecast of Total Taxes as Proportion of GDP with Budget Balancing (Mean and 95% Probability Interval, 1994 to 2070)

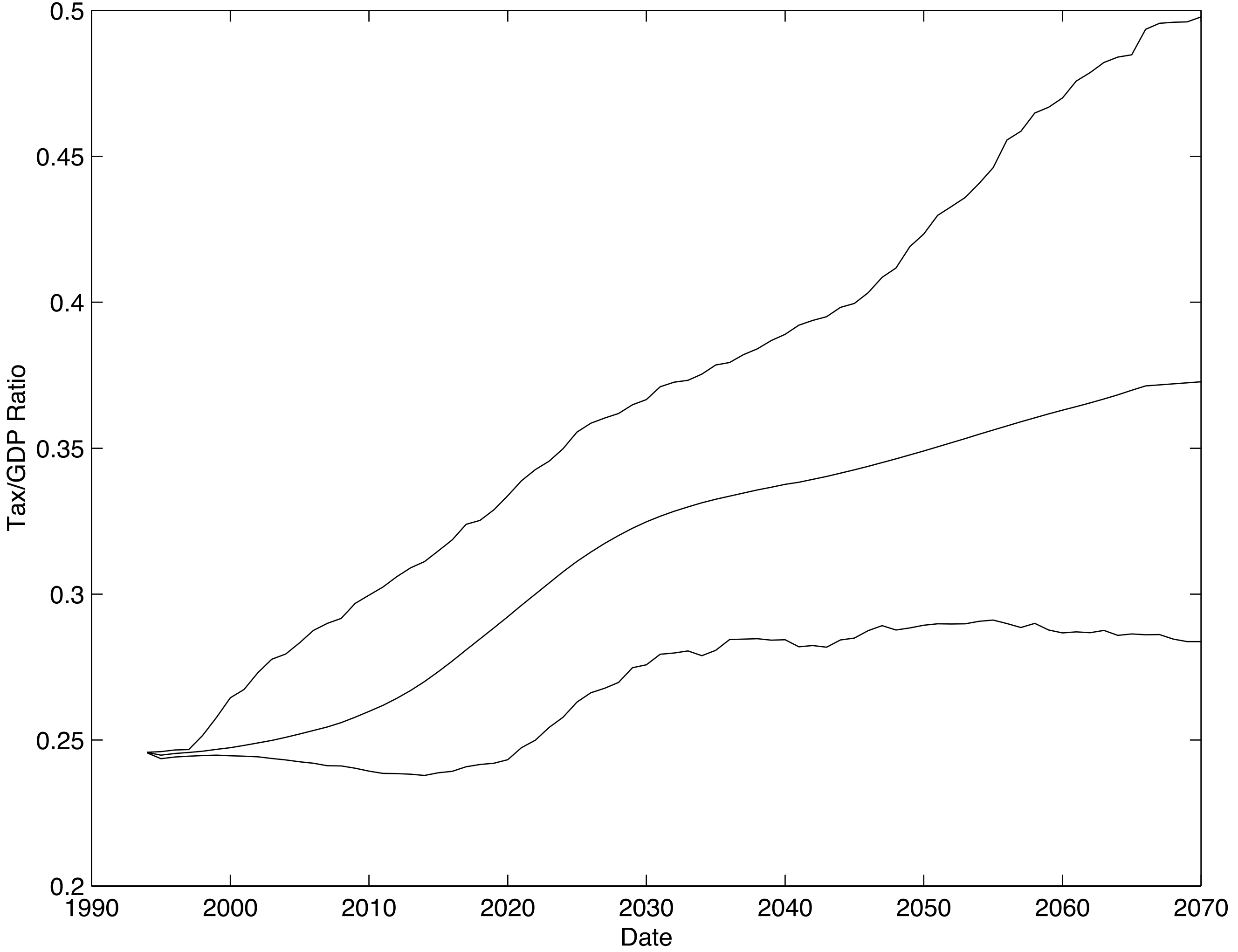


Figure 4: Forecast of Total State and Local Outlays as Proportion of GDP with Budget Balancing (Mean and 95% Probability Interval, 1994 to 2070)

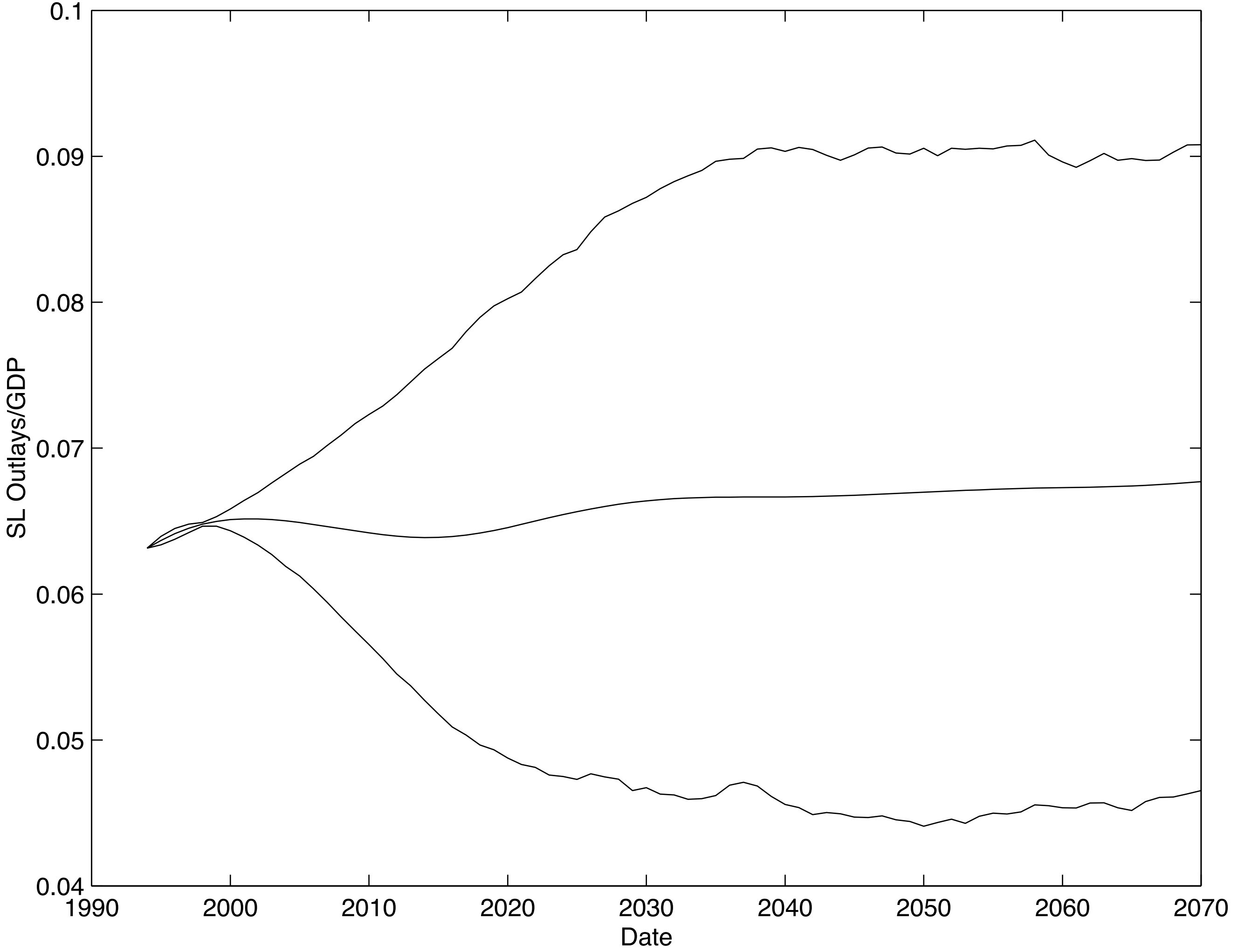


Figure 5: Forecast of Payroll Tax Rate for OASDI under Budget Balancing
(Mean and 95% Probability Interval, 1994 to 2070)

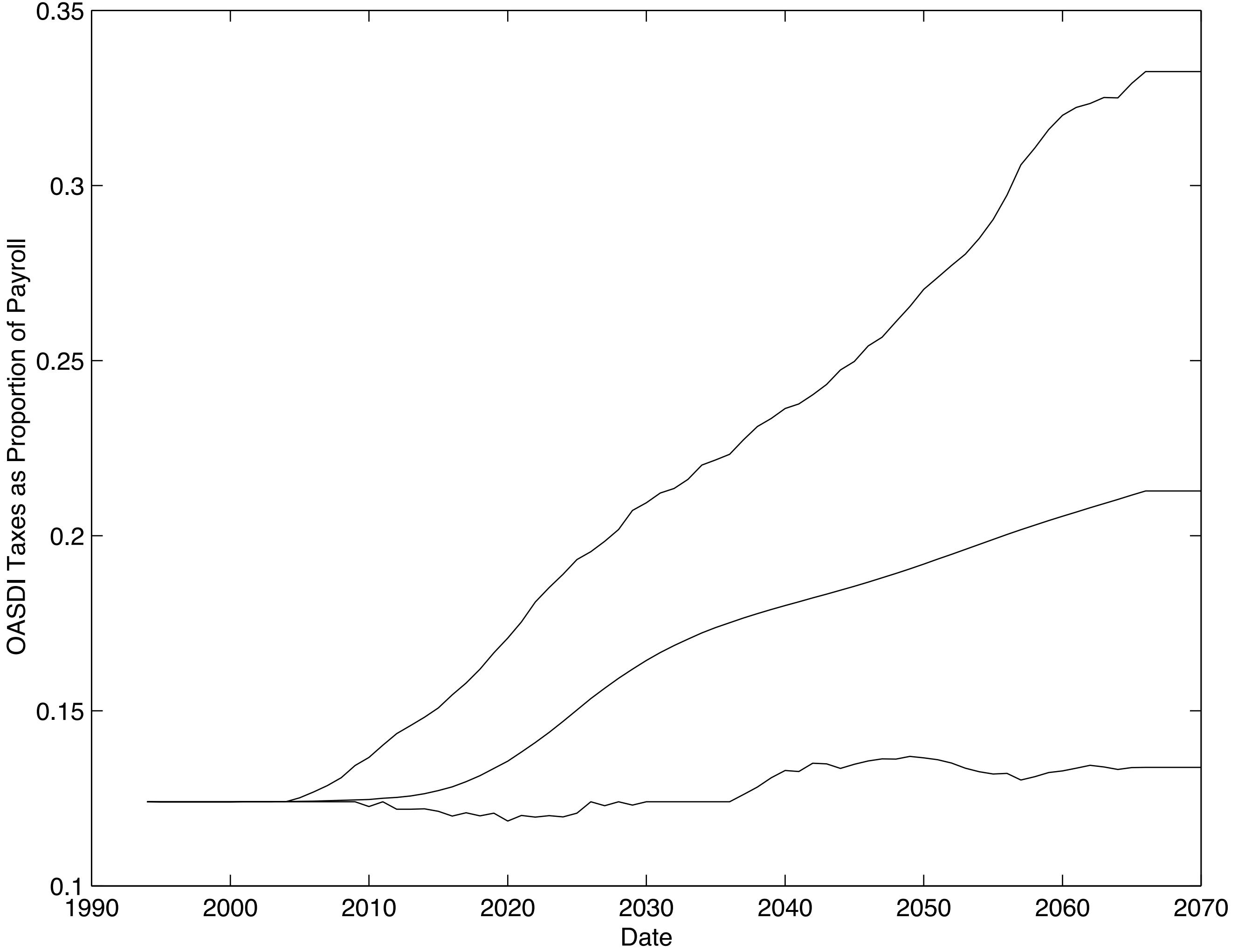


Figure 6. Forecast of Medicare (HI) Expenditures as a Proportion of GDP

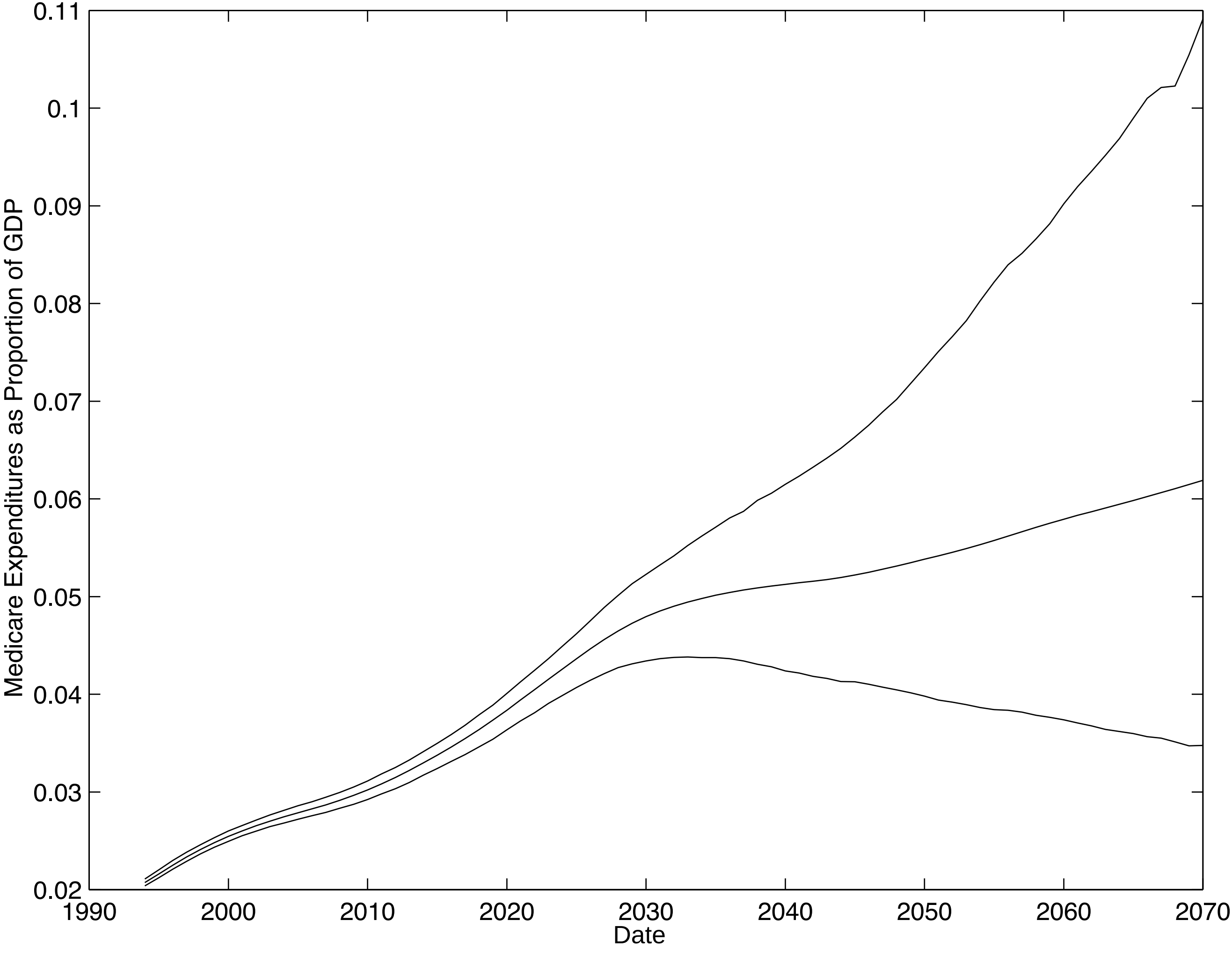


Figure 7: Mean Forecast of Expenditures for Programs for the Elderly, for Children, and for Age–Neutral Programs as Proportions of GDP, 1994–2070

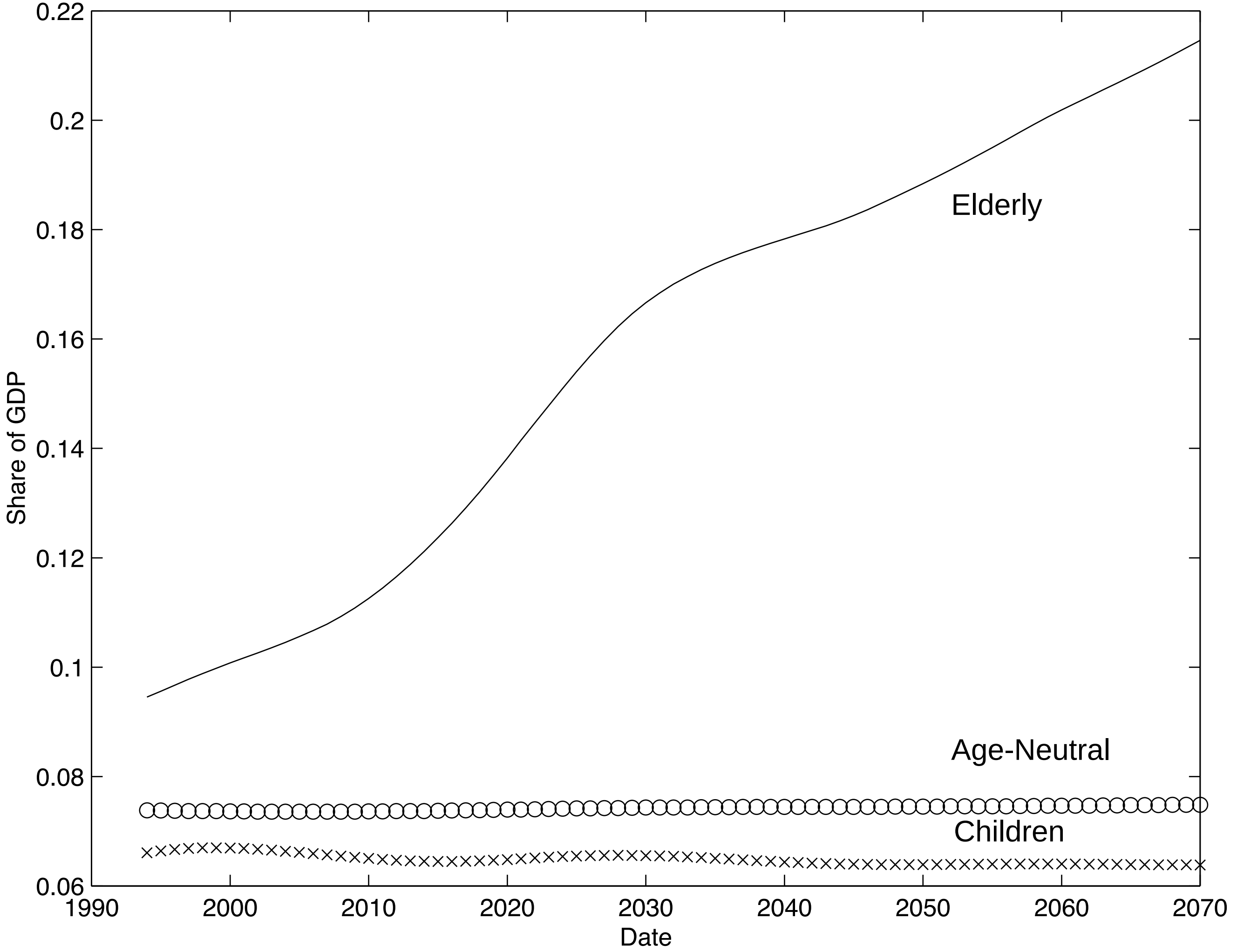


Figure 8. Forecasts of GDP Spending for Old, Young, and Age-Neutral Programs (Mean and 95% Probability Interval, 1994 to 2070)

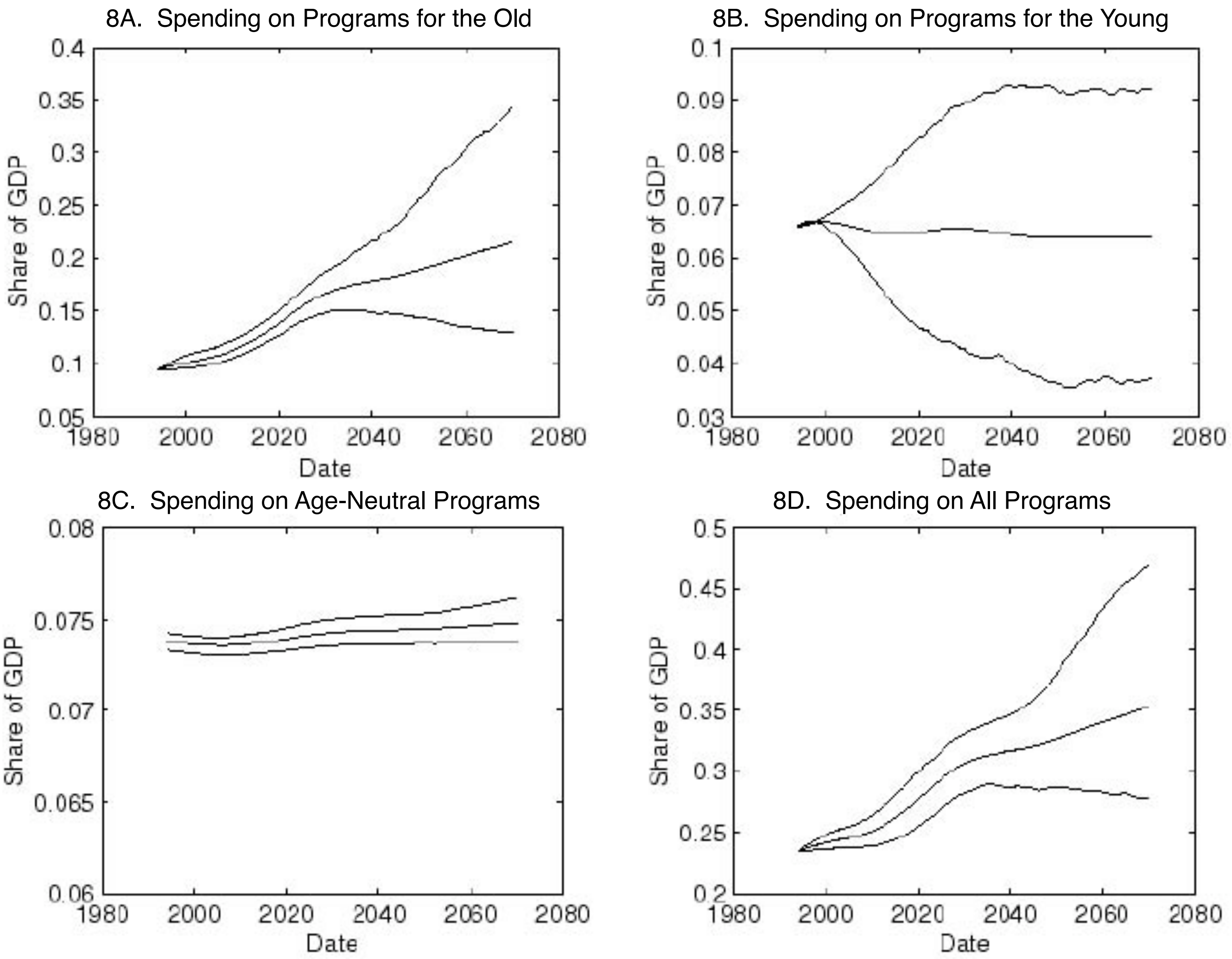


Figure 9: Correlations Between Spending on Children and Spending on the Elderly, 1994-2070

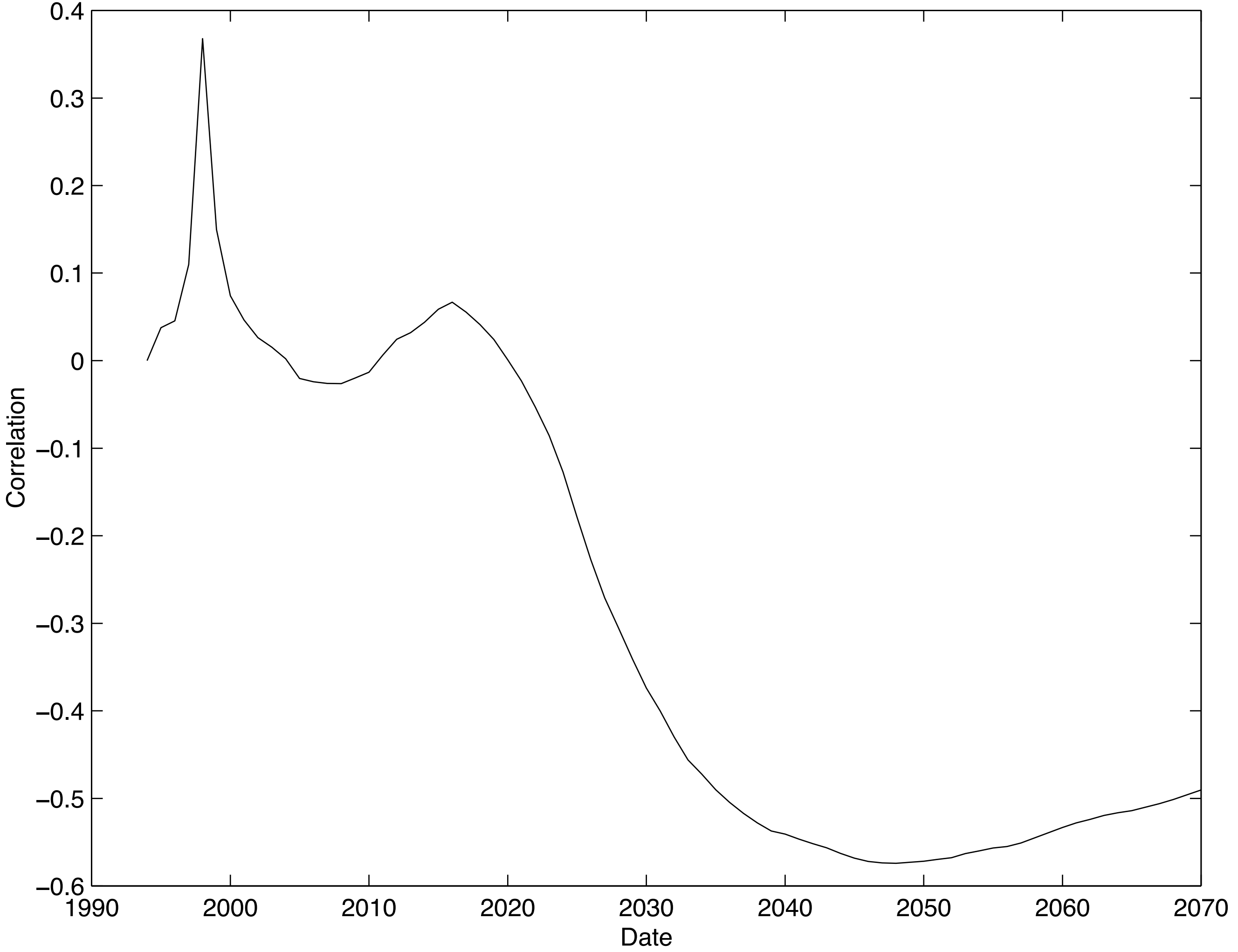


Figure 10. Mean Forecasts of Cumulative Proportions of GDP Spent on the Elderly (Aged 60+) by Program